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MANUAL OF
BACTERIAL PLANT PATHOGENS

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MANUAL OF BACTERIAL PLANT PATHOGENS

BY

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PREFACE

The material presented in the following pages is the outgrowth of a card catalogue of bacterial diseases of plants accumulated through a number of years and assembled in the present form in the hope that it may be of use to others interested in or working with bacterial plant pathogens.

Many of the books on plant pathology contain some information on the more common or more important bacterial diseases. Smith's books, devoted to bacterial diseases and methods, give detailed descriptions of a large number of diseases and causal organisms and Stapp in the fifth edition of Sorauer's Handbuch der Pflanzenkrankheiten gives the most complete record of bacterial plant diseases up to the present time. In all of these books the diseases are arranged according to hosts. It is intended here to place the emphasis on the causal organism and to bring together in one publication a complete alphabetical list of bacterial plant pathogens and associated organisms together with their synonyms and the source and date of publication of each name. This alphabetical list has been divided into two parts. The first part includes the plant pathogens and a few possible pathogens with a description of each organism and much of the available information on each disease. The second part is made up of non-pathogenic organisms associated in some way with plant diseases and included in the literature and published here merely as a source of reference. While the long lists of literature under many of the diseases may seem cumbersome, they are intended to serve as sources of more detailed information and to form a historical background with a very human interest.

In order that the various pathogenic organisms may be more readily compared, a chronological list has been prepared giving the chief morphological, cultural, and physiological characters of the organisms arranged in the form of a chart.

In the literature of plant pathology, at the present time, three different systems of bacterial nomenclature are being used. These are:

1. Migula, W. System der Bakterien 1900.
   - Bacillus = rods with peritrichiate flagella
   - Bacterium = non-motile rods
   - Pseudomonas = rods with one to several polar flagella

2. Smith, E. F. Bacteria in Relation to Plant Diseases I. 1905.
   Bacillus = rods with peritrichiate flagella
   Bacterium = rods with polar flagella
   Aplanobacter = non-motile rods
3. Committee Society American Bacteriologists (Bergey's Manual of Determinative Bacteriology, 1923, 1925, 1930).
   Plant Pathogens
   Erwinia = rods with peritrichiate flagella
   Phytomonas = rods motile or non-motile, motile forms possess polar flagella. (For a discussion of this Genus see;
   Burkholder, W. H. The Genus Phytomonas. Phytopath. 20: 1–23, 1930.)

Previous to 1905 bacterial plant pathogens were named according to Migula's classification and some plant pathologists still follow this system. The system proposed by the Committee of the Society of American Bacteriologists has not been officially accepted by the Society, nor has it been generally adopted by plant pathologists. Until such time as a general system of bacterial nomenclature is adopted or generally accepted, it seems to be least confusing to follow the system of nomenclature under which the largest number of bacterial plant pathogens have been named. Smith's modification of Migula's system has therefore been followed in the present list. The status of a few organisms has been considered so doubtful that it has not been thought advisable to add new combinations to the literature by renaming them according to Smith's classification.

A survey of the work done on bacterial diseases up to the present time will show that many of the diseases have been carefully worked out and the bacteria described in detail. Some of the work, on the other hand, has been carelessly done, or done by people with insufficient training. To establish the pathogenicity of an organism Koch's rules of proof must be followed. These rules are (1) isolation of the organism from the diseased tissue, (2) reproduction of the disease by pure culture inoculation on healthy plants, (3) reisolation of the organism from characteristically diseased tissue, and (4) the identification of the organism reisolated with the original isolation. When the pathogenicity of the organism has been established, its morphological, cultural, and physiological characteristics should be determined and reported in such a way that later workers will have no difficulty in identifying the organism. In comparing the characters of a new organism with those of organisms previously described, the media and

methods used by earlier workers should be taken into consideration. For example, with many organisms that are strong ammonia producers, acid production is masked in media containing peptone, whereas some of these organisms (Bact. phaseoli e.g.) will give an acid reaction from sugar in peptone-free synthetic media. Again, in beef infusion media many organisms produce a green fluorescence that is entirely lacking in beef extract media. The Manual of Methods for pure culture study of bacteria edited by the Committee on Bacteriological Technic of the Society of American Bacteriologists is the best source of information on methods and is continually being revised and improved.

A manual of this kind is not assembled without the assistance of many people not directly concerned. The writer is greatly indebted to members of the former Laboratory of Plant Pathology of the U. S. Department of Agriculture, Nellie A. Brown, Mary K. Bryan, Florence Hedges, and Lucia McCulloch, for advice as to the form of the work and for information in regard to particular organisms and diseases. The cooperation of the staff of the U. S. Department of Agriculture Library has made the work possible. The writer is particularly indebted to Miss E. B. Hawks for finding foreign and obscure publications and for obtaining books not available in the Department. Most of all the writer wishes to express her appreciation of the privilege of working for nine years in the laboratory and under the stimulating influence of Dr. Erwin F. Smith. His unusually complete files of literature, his enthusiastic interest in plant pathology, and his broad knowledge of the subject were sources of information and inspiration.

CHARLOTTE ELLIOTT.

Washington, D. C., December, 1929.

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Aplanobacter agropyri O'Gara, 1916

Non-motile; 0.4–0.6 x 0.6–1.1μ; short chains; capsules; Gram negative; not acid fast; agar colonies, growth slow, surface slightly roughened and concentrically ringed, opaque, raised, margin beaded to irregular, primuline yellow, very viscid; gelatin not liquefied; milk unchanged, casein not precipitated for three months but some casein precipitated at the end of four months; litmus milk slightly reduced; aerobic; no acid and no gas from sucrose, lactose, dextrose glycerin; slight clouding in bouillon, no pellicle or ring, yellow precipitate; nitrates reduced; diastatic action present; optimum temperature for growth between 25°–28°C.; thermal death point probably about 50°C. Pathogenicity not proved by inoculation.

Synonymy:

Phytomonas agropyri (O'Gara) Bergey et al., 1923.

Compare with *Aplanobacter rathayi.*

Compare with *Bacterium tritici.*

Symptoms: Affected plants are somewhat dwarfed but the most striking characteristic is the presence of enormous masses of surface bacteria which form a primuline yellow ooze or slime in layers between the stem and the upper sheath and between the glumes of the inflorescence. The floral organs are extensively occupied by the organism. Globules of ooze collect on the outer surface of glumes and sheaths and dry so that they look like particles of resin. Knee-shaped bendings often occur above the upper node and protrude through the sheath. The organism later enters substomatal chambers and intercellular spaces. Normal seeds are rarely produced from an infected inflorescence. Yellow gum disease.

Host: *Agropyron smithii.*

Geographical distribution: Utah, Montana.

Literature:

1915. O'Gara, P. J. A bacterial disease of western wheat grass. First account of the occurrence of a new type of bacterial disease in America. Science (n.s.), **42**: 616–617, 1915.

1916. O'Gara, P. J. A bacterial disease of western wheat grass, *Agropyron smithii;* occurrence of a new type of bacterial disease in America. Phytopath. **6**: 341–350, 1916, abstr. in Phytopath. **6**: 98–99,1916.

1917. O'Gara, P. J. Notes on the distribution of the bacterial disease of western wheat grass. Phytopath. **7**: 225–226, 1917 (note). (Paper read before Amer. Phytopath. Soc., Columbus, Ohio, Dec., 1915.)

1923. Bergey's Manual of Determinative Bacteriology, p. 190, 1923.

Aplanobacter betle (Ragunathan) n. comb.

Non-motile; 0.5 x 1.5–2.5μ; short chains; no spores; no capsules; aerobic; Gram negative; nutrient agar colonies raised, glistening, honey-yellow, no odour, medium slowly liquefied; viscid on gelatin, potato, carrot; gelatin liquefied; bouillon and gelatin turned light green; growth poor in Cohn's and Uschinsky's solutions; no growth in Fermi's; diastatic action; no gas.

Synonymy: *Bacterium betle* Ragunathan, 1928.

Symptoms: The disease first appears as minute water-soaked spots on the under surfaces of leaves. Later these appear on the upper surface as dark, rounded or angular areas surrounded by yellow zones. Surrounding zones on the lower surface have a water-soaked appearance. The centers of the spots are mottled brown turning black and rotting. The spots may coalesce to form large irregular dead areas which may fall out. Badly infected leaves yellow and fall. Under humid conditions a gummy exudate appears on the under surfaces of leaves. Stems may be attacked. Badly infected vines usually die.

Host: *Piper betle.*

Geographical distribution: Ceylon.

Control: Diseased leaves should be picked and burned as soon as the first symptoms appear. General sanitation is also recommended.

Literature:

1926. Ragunathan, C. Bacterial leafspot of betel. Ceylon Dept. Agric., Leaflet 39: 2 p., 1926. This organism is named but not described.

1927. Rhind, D. Ann. Rept. Mycologist Burma for year ending June 30, 1926: 4–5, 1927.

1928. Ragunathan, C. Bacterial leafspot of betel. Ceylon Jour. Sci., Sect. A, Bot. Ann., Roy. Bot. Gard. Peradeniya, 11 (1): 51–61, 1928.

Aplanobacter cepivorus (Delacroix) n. comb.

No flagella; 0.9 x 1.25μ; no spores; Gram negative; beef bouillon is clouded and becomes yellow and a thin incomplete pellicle is formed; colonies on gelatin are at first round, glistening and white later becoming irregular and metallic and slimy; gelatin is not liquefied; gas formed on agar and gelatin.

Synonymy:

Bacillus cepivorus Delacroix, 1906.

Bacterium cepivorum (Delacroix) Stapp, 1928.

Giampietro (1911) claims to have found *B. coli* and *B. cepivorus* identical. Chupp (1925) puts this under *B. carotovorus.*

Symptoms: The bulbs alone are attacked by this organism. The outer scales become dry and dull and the inner scales lose their lustre, become soft and oily and finally, as the middle lamella is destroyed, become a soft pulp with a disagreeable odor.

Host: *Allium cepa.*

Geographical distribution: France.

Control: Crop rotation should be practiced. The use of superphosphate of lime is also beneficial.

Literature:

1886. Sorauer, P. Handbuch der Pflanzenkrankheiten. Der rotz der Speisezwiebeln, II Aufl., 2: 103–109, 1886.
1899. Stewart, F. C. A bacterial rot of onion. New York (Geneva) Agr. Exp. Stat. Bul. 164: 209–212, 1899.
1906. Delacroix, G. Sur la maladie appelee "Gras de l'Oignon." Ann. Inst. Nat. Agron., 2 Ser., 5: 366–368, 1906.
1911. Giampietro, A. W. Un marciume delle cipolle dovuto ad un bacterio: *Bacillus coli* (nota preliminare). Rivista di Patologia Vegetale 5: 49–52, 1911. The author claims to have found *B. coli* as the cause of onion rot.
1925. Chupp, C. Manual of Vegetable Garden Diseases, p. 78, 1925.
1928. Passalacqua, T. Germogliazione patologica delle cipolle prodotta da *Bacterium cepivorum* (Delacr.) T. Pass. Nota preliminare. Curiamo le Piante! 6: 61–66, 1928. *Bacterium cepivorum* was isolated from decayed bulb tissue and reproduced the disease.
1928. Stapp, C. Schizomycetes (Spaltpilze oder Bakterien) in Sorauer's Handbuch der Pflanzenkrankheiten. 2 (fünfte auflage): 49, 1928.

Aplanobacter dissolvens (Rosen) Rosen, 1926

Motile or non-motile; 0.5–0.9 x 0.7–1.2μ; capsules; no spores; chains; facultative anaerobe; Gram negative; not acid fast; acid and gas from dextrose, galactose, mannit, sucrose, maltose, lactose, raffinose; agar colonies white, round, entire, glistening, opaque, some have strong putrid odor; nitrates reduced; ammonia and indol produced; hydrogen sulphide not produced; diastatic action marked; gelatin not liquefied; fair growth in Fermi's and Uschinsky's solutions; milk coagulated; growth on steamed potato cylinder is heavy, heaped up, creamy white, glistening and not slimy; optimum temperature 30°–35°C.; maximum about 40°C.

Synonymy:

Pseudomonas dissolvens Rosen, 1922.
Phytomonas dissolvens (Rosen) Rosen, 1926.
Bacterium dissolvens (Rosen) Rosen, 1926.

Rosen (1926) considers this organism closely related to *Bacillus coli.*

Symptoms: The signs of the disease are a light or dark brown rotting of bases of leaves especially those at the base of the stalk; dark brown spotting of husks and leaf blades; a rotting of the lower portion of the stalk, the affected part being dark brown, soft, water-soaked and sunken with a strong odor of decay. Lesions may be localized, dark rotted spots with water-soaked margins. The whole thickness of the stalk may be involved and it may break over and the plant die. The infected tissue drys as a mass of shredded, easily disjointed fibres, remnants of the fibrovascular bundles. Infection takes place through hydathodes, stomata and injuries.

Host: *Zea mays.*

Geographical distribution: New York, North Carolina, Mississippi, Louisiana, Ohio, Illinois, Arkansas, North Dakota, Arizona.

Literature:

1889. Billings, F. S. The cattle diseases in Nebraska, 1886–1888. II. The corn stalk disease in cattle. Nebraska Agr. Exp. Sta. Buls. 7, 8, 9, 10: 163–210, 1889.

1889. Burrill, T. J. A bacterial disease of corn. Univ. Illinois Agr. Exp. Sta. Bul. 6: 165–175, 1889.

1896. Moore, V. A. Cornstalk disease and rabies in cattle. U. S. Dept. Agr., B. A. I. Bul. 10: 9–65, 1896.

1910. Selby, A. D. A brief handbook of the diseases of cultivated plants in Ohio. Ohio Agr. Exp. Sta. Bul. 214: 390, 1910.

1917. Essary, S. H. Bacterial root rot of corn. U. S. Dept. Agr., B. P. I. Plant Dis. Bul. 3: 52, 1917.

1918. Cook, M. T. Diseases of grains and forage crops. New Jersey Agr. Exp. Sta. Circ. 102: 7, 1918.

1919. Rosen, H. R. A bacterial root-rot of field corn. Arkansas Agr. Exp. Sta. Bul. 162: 3–6, 1919.

1921. Rosen, H. R. A bacterial root and stalk rot of field corn. Phytopath. 11: 32–33, 1921. (Abstract.)

1921. Rosen, H. R. Further observations on a bacterial root and stalk rot of field corn. Phytopath. 11: 74–79, 1921.

1922. Rosen H. R. The bacterial pathogene of corn stalk rot. Phytopath. 12: 497–499, 1922.

1926. Rosen, H. R. Bacterial stalk rot of corn. Phytopath. 16: 241–267, 1926.

1926. Rosen, H. R. Bacterial stalk rot of corn. Arkansas Agric. Exp. Sta. Bul. 209: 1–28, 1926. Some strains are motile and some non-motile.

Aplanobacter insidiosum McCulloch, 1925

Non-motile; 0.4–0.5 x 0.7–1.0μ; capsules; no chains; no spores; Gram negative; not acid fast; aerobic; nutrient agar colonies round, smooth, glistening, flat to slightly raised, amorphous, white becoming pale yellow; growth in beef bouillon moderate without rim or pellicle; trace of growth in Uschinsky's solution; no growth in Fermi's or Cohn's; gelatin slowly liquefied; blood serum not liquefied or cleared; no indol, ammonia, or hydrogen sulphide produced; moderate diastatic action; soft curd in milk; casein not digested; growth yellow on most culture media, but on potato cylinders and on agar containing sugar, opaque dark blue granules develop in sufficient numbers to change the color to various shades of blue and green; litmus reduced; nitrates not reduced; no gas; acid from sucrose, dextrose, lactose, galactose and glycerin; optimum temperature about 23°C.; maximum 28°–31°C.; minimum below 1°C.; thermal death point 51°–52°C.

Synonymy:

Bacterium insidiosum (McCulloch) Stapp, 1928.

Phytomonas insidiosa (McCulloch) Bergey et al., 1930.

Symptoms: "The disease is chiefly vascular, the bacteria passing from tap root to each succeeding weakened crop of stems until the plant is killed." The most conspicuous symptoms are dwarfing of severely infected plants, yellowing of leaves at the margins and curling upward. Sometimes bleaching and drying

of the foliage of a few stems or of the margins of a few upper leaves are the only indications of disease. Clogging of the vascular system results in wilting and death of seedlings. When the disease is sufficiently developed to be evident in the foliage, the taproot shows a ring of yellow or pale brown discoloration in the outermost part of the woody cylinder just beneath the bark. This ring increases in width with the progress of the disease.

Hosts: *Medicago sativa*, *Melilotus alba*.

Geographical distribution: New Jersey, Pennsylvania, Indiana, Illinois, Michigan, Wisconsin, Minnesota, Iowa, South Dakota, Nebraska, Kansas, Missouri, Colorado, Utah, Idaho, South Carolina, Alabama, Mississippi; probably in all the older alfalfa growing districts of the United States.

Control: Seed from disease-free fields should be used if possible. Spread by mower can be greatly lessened by cutting only when the field is dry. When the disease has appeared in an irrigated field no more water than is necessary should be used. Cultivation of the field which wounds the crowns when the soil is wet should be avoided.

Literature:

1925. Jones, F. R. A new bacterial disease of alfalfa. Phytopath. **15**: 243–244, 1925.

1925. McCulloch, L. *Aplanobacter insidiosum* n. sp., the cause of an alfalfa disease. Phytopath. **15**: 496–497, 1925.

1926. Jones, F. R., and L. McCulloch. A bacterial wilt and root rot of alfalfa caused by *Aplanobacter insidiosum* McCulloch. Journ. Agr. Res. **33**: 493–521, 1926.

1927. Kirby, R. S., and W. A. Archer. Diseases of cereal and forage crops in the United States in 1926. U. S. Dept. Agric., B. P. I., Plant Disease Reporter, Suppl. **53**: 193, 1927.

1927. Nelson, R. Report of the Section of Botany. Michigan State Bd. Agric. 1926: 257, 1927.

1928. Jones, F. R. Development of the bacteria causing wilt in the alfalfa plant as influenced by growth and winter injury. Journ. Agr. Res. **37**: 545–569, 1928.

1928. Jones, F. R. Winter injury of alfalfa. Journ. Agr. Res. **37**: 189–211, 1928. "Winter injury when severe appears not only to shorten the life of plants but to furnish a convenient point of entry for the parasitic bacterium (*Aplanobacter insidiosum* L. McC.) which causes bacterial wilt."

1928. Jones, F. R., and J. L. Weimer. Bacterial wilt and winter injury of alfalfa. U. S. Dept. Agric. Circ. **39**: 1–8, 1928.

1928. Stapp, C. Schizomycetes (Spaltpilze oder Bakterien). In Sorauer's Handbuch der Pflanzenkrankheiten. 2 (fünfte auflage): 178–179, 1928.

1929. Haskell, R. J., and Jessie I. Wood. Diseases of cereal and forage crops in the United States in 1928. U. S. Dept. Agric., B. P. I., The Plant Disease Reporter, Sup. **71**: 308, 1929. "Weimer in a report to the Office of Vegetable and Forage Diseases said that bacterial wilt appeared to be more prevalent in eastern Kansas than at any time since its discovery. It was by far the most

important disease of alfalfa in that section. Many plants, in fact whole fields, were destroyed during the winter, apparently by this disease." "The winter-hardy variety Grimm is one of the most susceptible to wilt."

1930. Bergey's Manual of Determinative Bacteriology, p. 244, 1930. (3rd. ed.)

Aplanobacter maculicola (Delacroix) n. comb.

No flagella; 1.5 x 0.75μ; no spores; Gram negative; agar colonies small, round, glistening, at first cream colored and later bluish; gelatin liquefied; odor of nitrobenzine on gelatin.

Synonymy:

Bacillus maculicola Delacroix, 1905.

Bacterium maculicolum (Delacroix) Stapp, 1928.

Symptoms: Numerous spots occur on mature leaves, at first pale green then almost white. These multiply and increase in size to 3–4 millimeters in diameter, or may coalesce to form larger spots. Spots gradually dry and become dull white, rounded often angular, surrounded by a raised brown corky border. They may fall out leaving irregular holes in the leaf. The spots occur on mature leaves.

Host: *Nicotiana tabacum.*

Geographical distribution: Bulgaria, France, Greece, Italy.

Literature:

1894. Prillieux, E. E., et G. E. Delacroix. Maladies bacillaires de divers vegetaux. Compt. Rend. Acad. Sci. (Paris) **118**: 668–671, 1894. (The disease studied by us in 1894 was not mosaic but was rouille blanche and due to bacteria. 1905.)

1905. Delacroix, G. La ruille blanche du tabac et la nielle ou maladie de la mosaique. Compt. Rend. Acad. Sci. (Paris) **140**: 678–680, 1905.

1906. Delacroix, G. Recherches sur quelques maladies du tabac en France. La "Maladie des Taches blanches." Annales de l'Institut National Agronomique 2^e ser. **5**: 198–203, 1906.

1925. Savoff, C. (Some new and little known bacterial and fungal diseases of cultivated and wild plants in Bulgaria.) Rev. Inst. Rech. Agron. en Bulgarie. **3**: 149–162, 1925. (In Russian with French resumé.) White spots on tobacco leaves 3–8 mm. in diameter, round to irregular and surrounded by dark margins of cork tissue—due to *Bacillus maculicola* Del.

1928. Petri, L. Rassegna dei casi fitopatologici osservati nel 1927. Boll. R. Staz. Pat. Veg. (Rome) **8**: 48, 1928. *Bacillus maculicola* was found on tobacco from the Trentino (Italy).

1927. Cavadas, D. S. Bacterial diseases of tobacco in connection with *Gnorimoschema heliopa* in Thessaly. Internat. Rev. Agr. 18th year (n. s.) No. 11: 1357–1358, 1927. *Bacillus maculicola* Del. in neighborhood of Volo.

1928. Stapp, C. Schizomycetes (Spaltpilze oder Bakterien). In Sorauer's Handbuch der Pflanzenkrankheiten. **2** (fünfte auflage): 276–277, 1928.

Aplanobacter michiganense (E. F. Smith) E. F. Smith, 1914

Non-motile; 0.35–0.4 x 0.8–1.0μ; non-sporiferous; Gram positive; not acid fast; aerobic; colonies on beef peptone agar small, circular, yellow, viscid; liquefies gelatin slowly; coagulates milk slowly forming a pellicle and wide yellow bacterial rim; turns litmus milk gray or purplish red before reducing the litmus; growth on potato cylinders at first pale yellow, becoming bright yellow, smooth and inclined to spread; the potato cylinder is grayed; growth in bouillon and on gelatin and agar plates very slow; does not grow in Cohn's or Uschinsky's solutions; nitrates not reduced; no gas formed; sensitive to heat, acids and sodium chloride; no immediate acid from lactose, galactose, maltose, mannit, or glycerin.

Synonymy:

Bacterium michiganense E. F. Smith, 1910.

Pseudomonas michiganense (E. F. Smith) Stevens, 1913.

Phytomonas michiganensis (E. F. Smith) Bergey et al., 1923.

See *Aplanobacter sepedonicum.*

See Smith, 1920, for comparison with brown rot of Solanaceae.

Symptoms: This is a vascular wilt disease of the tomato which progresses from the lower leaves upward causing a slow wilting, browning and dying of the leaves which hang from the turgid petioles. Only one side of a plant may be attacked. Yellowish white streaks, frequently becoming gray-brown appear on the stems especially the upper tender shoots where infection is near the surface. These streaks often crack open, forming characteristic cankers and allowing the bacteria to come to the surface and infect neighboring plants. The inner phloem is especially susceptible, through the stomata, to attack and along this line the wood separates from the pith. Large areas in the pith also become diseased and yellow and form yellow or reddish brown cavities. The bacteria penetrate the seed coat through the vascular system without external evidence of injury to the fruit, such fruits when cut open show extensive yellow discoloration in the placenta which swarms with bacteria. These diseased fruits may ripen normally or prematurely. Severely infected young fruits are stunted and distorted but a rot of the fruit does not occur. Bryan (1920) has recently described a characteristic fruit spot as round, at first white, later with a light brown roughened center surrounded by a white halo. These spots may fuse to form large roughened patches. In late stages the spots are dark brown but often retain the white halo. Grand Rapids disease, bacterial canker.

Hosts: *Lycopersicum esculentum,* (Smith (1920) says "I believe it occurs also on the potato but the evidence is not yet conclusive," pp. 219–222), *Solanum mammosum.*

Geographical distribution: Maryland, Massachusetts, Connecticut, New York, New Jersey, Pennsylvania, Michigan, Indiana, Illinois, Ohio, Iowa, Georgia, Mississippi, Montana, Utah, California, Washington, British Columbia, Manitoba, Italy, Germany.

Control: It was found in Ohio that the disease was carried from plant to plant on the hands of workmen and on the pruning knives. Prompt eradication of diseased plants and adoption of sanitation controlled the disease. Bryan, 1928, recommends seed sterilization with mercuric chloride 1:3,000 for five minutes and washing 10–15 minutes; selection of seed from healthy plants; the use of clean fresh soil in seed beds; crop rotation.

Literature:

1910. Smith, E. F. A new tomato disease of economic importance. Science (n. s.) **31**: 794–796, 1910. This is the first description of the disease.

1913. Stevens, F. L. The fungi which cause plant disease, p. 30, 1913.

1914. Smith, E. F. Bacteria in relation to plant diseases **3**: 161–165, 1914.

1915. Peglion, V. L'avvizzimento bacteriaceo del pomodoro. Atti R. Accad. Naz. Lincei Rend. Cl. Sci. Fis., Mat. e Nat. **24**: 157–160, 1915. Also in Le malattie crittogamiche delle piante coltivate, 4th ed., 341–346, 1922.

1919. Paine, S. G., and W. F. Bewley. Studies in bacteriosis IV. "Stripe" disease of tomato, comparison of the stripe disease with the Grand Rapids tomato disease. Ann. Appl. Biol. **6**: 200–202, 1919. "It is tentatively suggested that the Grand Rapids tomato disease, described by Smith, may be identical with this stripe disease and that the organism which has been described as the cause of the Grand Rapids disease may prove to a saprophyte." Paine, 1922, 1923, reported that the diseases and organisms were distinct.

1920. Smith, E. F. An introduction to bacterial diseases of plants, p. 202–222, 1920.

1922. Paine, S. G., and M. S. Lacey. Studies in bacteriosis VII. Comparison of the "stripe disease" with the "Grand Rapids disease" of tomato. Ann. Appl. Biol. **9**: 210–212, 1922.

1923. Bergey's Manual of Determinative Bacteriology, p. 191–192, 1923.

1923. Paine, S. G., and M. S. Lacey. Studies in bacteriosis X. "The use of serum-agglutination in the diagnosis of plant parasites." Ann. Appl. Biol. **10**: 204–209, 1923. By this method *Aplanobacter michiganense* is entirely distinct from *Bacillus lathyri*.

1924. Berridge, E. M. The influence of hydrogen-ion concentration on the growth of certain bacterial plant parasites and saprophytes. Ann. Appl. Biol. **11**: 73–85, 1924.

1924. McLarty, H. R. A bacterial disease of tomatoes new to British Columbia. Report of the Dominion Field Laboratory of Plant Pathology. Summerland, B. C. Rept. Dominion Bot. for the year 1924, Div. of Bot., Canada Dept. Agr. 1924: 75–77, 1924.

1925. Anderson, H. W. A serious bacterial disease of tomatoes in southern Illinois. Illinois State Hort. Soc. News Letter **6**: (1), 1925. Identified as "Grand Rapids" disease.

1925. Brookes, R. St. John, K. Nain, and M. Rhodes. The investigation of phytopathogenic bacteria by serological and biochemical methods. Journ. Path. and Bact. **28**: 203–209, 1925.

1925. McLarty, H. R., and T. M. C. Taylor. A bacterial disease of tomatoes new to British Columbia. Phytopath. **15**: 302, 1925. (Abstract.) The disease was limited in extent but in one plot 75 per cent of the crop was lost.

1928. Bisby, G. R., and I. L. Conners. Plant diseases new to Manitoba. Scientific Agriculture **8**: 456–458, 1928.

1928. Bryan, M. K. Bacterial canker of tomatoes. U. S. Dept. Agric. Circ. 29: 7 pp., 1928.
1928. Jones, L. K., and Carl S. Pederson. Bacterial canker of tomatoes. New York State College of Agric., Cornell Extension Bul. 170: 1–4, 1928.
1928. Newton, G. A. Department of Plant Pathology. Western Washington Agr. Exp. Sta. Bul. 10W: 23, 1928. *Aplanobacter michiganense* reported on tomato in Washington for the first time.
1928. Shapovalov, M. California tomato diseases. U. S. Dept. Agric., B. P. I., Plant Disease Reporter 12: 108, 1928.
1928. Botany and Plant Pathology. Ohio Agric. Exp. Sta. Bul. 417: 34–41, 1928.
1929. Bryan, M. K. A fruit spot of tomato caused by *Aplanobacter michiganense*. Phytopath. 19: 690, 1929.
1929. Kotte, W. Der Bakterienkrebs, eine für Deutschland neue Tomatenkrankheit. Der Obst. und Gemusebau. 75: 186–188, 1929.
1929. Riker, A. J. Studies on the influence of environment on infection by certain bacterial plant parasites. Phytopath. 19: 96, 1929.

Aplanobacter rathayi E. F. Smith, 1913

Non-motile; 0.6–0.75 x 0.75–1.5μ; capsules; no spores; Gram positive; not acid fast; yellow on culture media; does not grow well on agar but grows well on cooked potato where it is viscid after some days; makes a copious yellow growth in milk and causes slow separation of casein; litmus milk is slowly blued and somewhat reduced; nitrates not reduced; does not grow in Cohn's solution; acid but no gas from grape sugar; gelatin slowly liquefied.

Synonymy:

Phytomonas rathayi (E. F. Smith) Bergey et al., 1923.

Bacterium rathay (E. F. Smith) Stapp, 1928.

Compare with symptoms due to *Aplanobacter agropyri* and *Bacterium tritici*. His inoculations failed but he was convinced that the bacteria were the primary cause of the disease and that special conditions were necessary for infection.

Symptoms: A yellow bacterial slime appears on the surface and causes a dwarfing and distortion of the upper part of the plant through incomplete elongation of the upper internodes. The yellow slime may envelop wholly or in part the uppermost leaves, the upper part of the stem and different parts of the inflorescence. Because of the sticky slime the branches often form knee-shaped bendings, due to elongation of the under part of the stem and the inflorescence may push out laterally. Infected parts dry prematurely. In the leaves the bacteria are found only in the vessels of the wood but in the stem they occur in the intercellular spaces of the parenchyma as well as in the vascular bundles.

Hosts: *Dactylis glomerata*. Reported on *Secale cereale*, *Capriola* (*Cynodon*) *dactylon*.

Geographical distribution: Denmark, Austria, Germany.

Control: Stapp, 1928, recommends the use of seed from disease-free fields.

Literature:

1899. Rathay, E. Über eine bakteriose von *Dactylis glomerata* L. Sitzber. Akad. Wiss. Wein, Math. Naturw. Kl. 108: 597–602, 1899.

1913. Smith, E. F. A new type of bacterial disease. Science (n. s.) **38**: 926, 1913.

1914. Smith, E. F. Bacteria in relation to plant diseases **3**: 155–160, 1914.

1917. Lind, J. Hundegraesbakteriosen (*Aplanobacter rathayi*). Tidsskr. for Planteavl. **24**: 255, 1917. In Austria and Denmark.

1923. Bergey's Manual of Determinative Bacteriology, p. 192–193, 1923.

1925. Dorph-Petersen, K. Beretning fra Statsfrøkontrollen for det 53. Arbejdsaar fra 1 July 1923 til 3 Juni 1924. Tidsskr. for Planteavl. **31**: 87–148, 1925. He reports *Aplanobacter rathayi* on seed of dog's tooth grass, *Cynodon dactylon*.

1927. Gram, E., C. A. Jørgensen, and S. Rostrup. Oversigt over Sygdomme hos landbrugets og havebrugets kulturplanter i 1926. Tidsskr. for Planteavl. **33**: 781–841, 1927. (English summary.) *Dactylis glomerata* was so severaly injured by *Bacterium rathayi* in one locality that the crop was mowed down.

1927. Flachs. *Aplanobacter rathayi* E. F. S. an Roggen. Illust. Landw. Zeit. Berlin **47**: 262, 1927. Rye near Staffelstein (Bavaria) was attacked by *Aplanobacter rathayi* causing malformation of the heads. Infection is supposed to take place through contact with diseased plants.

1928. Stapp, C. Schizomycetes (Spaltpilze oder Bakterien). In Sorauer's Handbuch der Pflanzenkrankheiten. **2** (fünfte auflage): 36–37, 1928.

Aplanobacter rhaponticum (Millard) n. comb.

Non-motile; 0.4 x 1.75–2.28μ; no spores; Gram negative; gelatin not liquefied; no indol; growth on nutrient rhubarb agar flesh color to slightly yellow; no gas; acid from dextrose, sucrose, mannit, maltose, levulose, galactose, arabinose, dextrin, salicin, lactose, glycerin; milk curdled.

Synonymy:

Bacterium rhaponticum Millard, 1924.

Phytomonas rhapontica Millard, 1924.

(The author states that this organism belongs to the *Bacillus coli* group.)

Symptoms: The signs of this disease are a soft brown rot near the crown of the root, brown swollen bases of stalks and leaf sheaths, absence of terminal bud, and the production of spindly rhubarb sticks from the lateral buds. Eventually the tissues below the crown rot and the head breaks away.

Host: *Rheum rhaponticum*.

Geographical distribution: Great Britain.

Control: Infected plants should be destroyed and all rotted tissue from infected plants removed from the soil or treated with a solution of ammonia (3.5 per cent by volume, 2 gals. per sq. yd.). The use of green manure instead of the organic matter applied at present is recommended. Some strains of the Victoria variety are believed to be more resistant than others.

Literature:

1924. Millard, W. A. Crown rot of rhubarb. Univ. Leeds and Yorkshire Council for Agric. Education. Bul. 134: 1–28, 1924.

Aplanobacter rhizoctonia Thomas, 1922

Non-motile; 0.4–0.85 x 0.9–1.9μ; chains; no capsules; Gram negative; not acid fast; aerobic; agar colonies 24 hours old, greenish yellow, later olive buff and finally after three to four days pyrite yellow, round, entire, raised, not noticeably viscid; heavy yellow pellicle formed on peptonized beef bouillon after two to three weeks; no acid or gas; gelatin slowly liquefied; milk curdled and peptonized; nitrates reduced; ammonia produced; diastatic action on potato starch; indol produced; no hydrogen sulphid; no growth in Cohn's solution; thermal death point between 51 and 52°C.; maximum temperature for growth 38°C.; minimum below 0°C.; optimum 25–27°C.

Synonymy: *Bacterium rhizoctonia* (Thomas) Stapp, 1928.

Symptoms: Infected plants show retarded growth or tendency to rosette accompanied by a yellowing or flaccid condition of the outer leaves. Plants infected in the seedling stage never mature sufficiently for marketing. If infection occurs after the plants have been transplanted a fair crop may be obtained but the date of maturity may be extended from 1 to 3 weeks. Sections of stems and roots reveal a yellowish or brownish substance in portions of the vascular system, particularly the xylem. In badly diseased plants the brown color may extend through the entire system. It is thought that the yellow color is due to bacterial action and the brown to secondary organisms. The root system is most seriously affected. Small fibrous roots are attacked at the tips and soon cease to function. Infection spreads slowly into the larger roots. These very readily become detached when the plant is pulled from the soil. "The chief rôle of the organism seems to be to attack the root hairs and small fibrous roots, gain entrance into the vascular system and interfere with free passage of food material."

Host: *Lactuca sativa.*

Geographical distribution: Ohio (greenhouses).

Control: The disease can be controlled by saturating the soil, previous to planting, with formalin (3–3½ pints to 50 gallons of water) at the rate of one or more gallons per square foot. After treatment beds should be covered with canvas for 48 hours. The soil should then be allowed to dry for a week or ten days before planting the lettuce. Steam sterilization is also effective.

Literature:

1920. Thomas, R. C. A new lettuce disease. Monthly Bulletin, Ohio Agr. Exp. Sta. 5: 24–25, 1920. A preliminary report of this disease.

1922. Thomas, R. C. A bacterial rosette disease of lettuce. Ohio Agr. Exp. Sta. Bul. 359: 197–214, 1922.

1928. Stapp, C. Schizomycetes (Spaltpilze oder Bakterien). In Sorauer's Handbuch der Pflanzenkrankheiten, 2 (fünfte auflage): 290, 1928.

Aplanobacter sepedonicum (Spieckermann) E. F. Smith, 1920

Non-motile; 0.5–0.6 x 1.1–1.2μ; chains; no capsules; no spores; Gram positive; aerobic; beef agar colonies circular, yellow, margin entire, slightly raised; gelatin not liquefied; growth on cooked potato slimy, yellowish-white, sometimes

feebly brownish; growth in beef peptone bouillon feeble, without pellicle; milk curdled but not cleared; curd in milk due to lab ferment; ammonia and indol not produced; litmus not reduced; diastatic action present; no gas from glucose; optimum temperature 20°–25°C.; maximum under 31°C.; thermal death point 45°–50°C.

Synonymy: *Bacterium sepedonicum* Spieckermann, 1913.

Smith (1920) says he suspects this organism may be the same as *Aplanobacter michiganense.* Stapp (1928) says they are not identical.

Symptoms: This is a vascular disease characterized by yellowing, rolling and drying of the leaves and a wet rot of the vascular ring of the tuber. The translucent yellow to light brown zones along the vascular bundles are of a soft pulpy consistency and generally measure only a few millimeters in width. In severe cases the softening may extend outward almost to the epidermis and inward almost to the center. When the whole vascular ring is destroyed the eyes are dead and black. If diseased tubers are planted, the sprouts may not grow at all or may produce sickly plants with rolled leaves. One stalk may be badly diseased and another apparently healthy. The stem may be marked with dark streaks which extend out into the petiole.

Hosts: (natural) *Solanum tuberosum;* (artificial) *Lycopersicum esculentum, Lycopersicum racemigerum, Solanum citrullifolium, Solanum commersonii.*

Geographical distribution: Germany: East Prussia, Westphalia.

Control: Only disease-free seed should be planted and long crop rotations should be practiced with immune crops. Stapp, 1928, recommends the use of uncut tubers for planting. If this is not possible the tubers should be cut 1–2 days before planting to allow the formation of a protective cork layer over the cut surface and thus shut out the causal organism.

Literature:

1906. Appel, O. Neuere Untersuchungen über Kartoffel und Tomatenerkrankungen. Jahresbericht der Vereinigung f. Angew. Bot. **3**: 132–135, 1906.

1910. Spieckermann, A. Ueber eine noch nicht beschriebene bakterielle Gefasserkrankung der Kartoffelpflanze. (vorlaufige Mitteilung). Centralb. f. Bakt. **27**: 205–208, 1910.

1911. Spieckermann, A. Beitrage zur Kenntnis der Bakterienring-und Blattrollkrankheiten der Kartoffelpflanze. Jahresbericht der Vereinigung für Angewandte Botanik, Achter Jahrgang 1910: 1–19, 173–177, 1911.

1912. Spieckermann, A. Die Krankheiten der Kulturpflanzen in Westfalen und ihre Bekampfung. Bericht über die Jahre 1910, 1911, 1912: 30–33. Veröffentlichungen der Landw. für die Provinz Westfalen. Heft 17.

1913. Spieckermann, A. Zur Kenntnis der in Deutschland auftretenden Gefasskrankheiten der Kartoffelpflanze. Landwirtsch. Zeitung **33**: 680–682, 1913.

1914. Spieckermann, A., and P. Kotthoff. Untersuchungen über die Kartoffelpflanze und ihre Krankheiten. 1. Die Bakterienringfaule der Kartoffelpflanze. Landwirtsch. Jahrbucher. **46**: 659–728, 1914.

1914. Smith, E. F. Bacteria in relation to plant diseases, **3**: 166–167, 1914. Smith here discusses Spieckermann's early papers in detail.
1915. Appel, O. Leaf roll diseases of the potato. Phytopath. **5**: 139–148, 1915.
1920. Smith, E. F. An introduction to bacterial diseases of plants, p. 207, 1920.
1926. Krankheiten und Beschadigungen der Kulturpflanzen im Jahre 1921. Mitt. Biol. Reichsanst. für Land.-und Forstw. **29**: 151, 1926. *Bacterium sepedonicum* recorded in two localities in East Prussia on var. Modell.
1927. Stapp, C. Die Bakterienringfäule der Kartoffel. (The bacterial ring rot of the potato.) Arb. Biol. Reichsanst. für Land.- und Forstwirtsch. Flugb. 36 (5th ed.): 4 pp., 1927. A brief popular description is given of the external and internal symptoms of bacterial ring rot of potatoes (*Bacterium sepedonicum* Spieckermann) first observed in Germany at the beginning of the 20th century. From Rev. Appl. Mycol. **7**: 50, 1928.
1928. Stapp, C. Schizomycetes (Spaltpilze oder Bakterien). In Sorauer's Handbuch der Pflanzenkrankheiten, **2** (fünfte auflage): 257, 1928.
1928. Krankheiten und Beschadigungen der Kulturpflanzen im Jahre 1927. Mitt. Biol. Reichsanst. für Land.-und Forstwirtsch. **37**: 136, 1928. Ring disease of potato was severe in Hanover.

Aplanobacter stewarti (E. F. Smith) McCulloch, 1918

Non-motile; non-flagellate; 0.5–0.7 x 1.0–2.0μ; non-sporiferous; short chains; Gram negative; slow growth on agar plates forming small, round, yellow colonies some of which have a smooth flat surface and others definite central depressions; growth on gelatin slow, slightly roughened, bright buff yellow; gelatin not liquefied; aerobic; no gas; acid from dextrose, sucrose, galactose and mannit; no acid from glycerine; milk not coagulated; litmus milk slightly reddened; nitrates not reduced; no hydrogen sulphide; very little diastase produced; no growth in Cohn's solution; long copious growth in Uschinsky's solution; feeble growth in Fermi's solution; no indol production in ten days; thermal death point about 53°C.; maximum temperature about 39°C.; optimum above 30°C.; minimum 8–9°C.

Synonymy:

Pseudomonas stewarti E. F. Smith, 1898.
Bacterium stewarti (E. F. Smith) E. F. Smith, 1914.
Phytomonas stewarti (E. F. Smith) Bergey et al., 1923.

Symptoms: This is a vascular disease characterized by the formation of yellow slime in the vascular system, browning of the nodes, dwarfing of the plants and drying out of leaves. Long, wilted, pale green streaks on the leaf blade extend from the point of entry of the parasite until the whole plant wilts and dies. Conspicuous yellowing never results, some green persisting even in dead plants. Tassels may develop prematurely and die before the rest of the plant. Yellow viscous beads exude from the cut ends of bundles.

Host: *Zea mays.*

Geographical distribution: It occurs in the middle region of the United States from New York and Maryland to California.

Control: Only seed from disease-free plants should be used. Where this is not possible seed should be carefully selected and treated with mercuric chloride 1:1,000 for twenty minutes before planting. Seed may also be disinfected by dry heat at 60°–70°C. for one hour. Northern grown seed is less likely to carry infection than seed grown farther south, and late varieties show a lower percentage of infection than early varieties. Growth of resistant varieties is the best known means of control. Country Gentleman, Early Ideal, Stowell's Evergreen and Ne Plus Ultra are comparatively resistant.

Literature:

1897. Stewart, F. C. A bacterial disease of sweet corn. New York (Geneva) Agr. Exp. Sta., Bul. 130: 423–439, 1897.

1898. Smith, E. F. Notes on Stewart's sweet corn germ, *Pseudomonas stewarti* n. sp. Proc. Amer. Assoc. Adv. Sci. **47**: 422–426, 1898.

1901. Smith, E. F. The cultural characters of *Pseudomonas hyacinthi*, *Ps. campestris*, *Ps. phaseoli*, and *Ps. stewarti*, four one-flagellate yellow bacteria parasitic on plants. Div. Veg. Phys. and Path., U. S. Dept. Agric., Bul. 28: 7–153, 1901.

1903. Smith, E. F. Completed proof that *P. stewarti* is the cause of the sweet corn disease of Long Island. Science **17**: 457, 1903.

1909. Smith, E. F. Seed corn as a means of disseminating *Bacterium stewarti*. Science **30**: 223–224, 1909. (Abstract.)

1912. Smith, E. F. A new method in bacterial research. Phytopath. **2**: 214–215, 1912.

1914. Smith, E. F. Bacteria in relation to plant diseases. **3**: 89–147, 1914.

1917. Garman, H. A new sweet corn disease in Kentucky. Kentucky Agr. Exp. Sta. Circ. **13**: 2 pp., 1917.

1918. McCulloch, L. A morphological and cultural note on the organism causing Stewart's disease of sweet corn. Phytopathology **8**: 440–441, 1918.

1921. Rand, F. V., and L. C. Cash. Stewart's disease of corn. Journ. Agr. Res. **21**: 263–264, 1921.

1921. Reddy, C. H. Experiments with Stewart's disease on dent, flint and sweet corn. Phytopath. **11**: 31, 1921. (Abstract.)

1923. Bergey's Manual of Determinative Bacteriology, p. 192, 1923.

1923. Rand, F. V. Bacterial wilt or Stewart's disease of corn. Canner **56**: 164–165, 1923.

1924. Rand, F. V., and L. C. Cash. Further evidence of insect dissemination of bacterial wilt of corn. Science **59**: 67–69, 1924. Results of experiments indicate that *Diabrotica duodecempunctata* is probably an important source of early infection. *Chaetocnema pulicaria* and *Chaetocnema denticulata* are responsible for much of the mid-season spread of the disease.

1924. Thomas, R. C. Stewart's disease or bacterial wilt of sugar corn. Monthly Bul., Ohio Agr. Exp. Sta., **9**: 81–84, 1924. Early maturity seems to be correlated with susceptibility to the disease.

1925. Brookes, R. St. John, K. Nain and M. Rhodes. The investigation of phytopathogenic bacteria by serological and biochemical methods. Journ. Path. and Bakt. **28**: 203–209, 1925. See *Bacillus carotovorus*.

1926. Reddy, C. S., J. R. Holbert, and A. T. Erwin. Seed treatments for sweet-corn diseases. Journ. Agr. Res. **33**: 769–779, 1926. Seed treatment with organic mercury compounds did not prevent bacterial blight due to *Aplanobacter stewarti*.

1928. Gardner, M. W. Indiana plant diseases, 1926. Proc. Indiana Acad. Sci. **37**: 412–415, 1928.

1928. Reddy, C. S., and J. R. Holbert. Differences in resistance to bacterial wilt in inbred strains and crosses of dent corn. Journ. Agr. Res. **36**: 905–910, 1928.

1928. Stapp, C. Schizomycetes (Spaltpilze oder Bakterien) in Sorauer's Handbuch der Pflanzenkrankheiten. 2 (fünfte auflage): 14–15, 1928.

Aplanobacter teutlium (Metcalf) E. F. Smith, 1920

Non-motile; no flagella; 0.8 x 1.5μ; chains; no capsules; no spores; Gram positive; dirty white on gelatin and agar; agar liquefied; gelatin not liquefied; milk not curdled; thermal death point 44–46°C.; sensitive to sunlight and desiccation; facultative anaerobe; no gas; no odor of indol, sulphuretted hydrogen or ammonia; no growth in fermentation tubes containing peptone water plus 1 per cent of lactose, maltose, dextrin, mannit, levulose, galactose, glycerin.

Synonymy:

Bacterium teutlium Metcalf, 1904.

Phytomonas teutlia (Metcalf) Bergey et al., 1930.

Metcalf says the organism is non-motile. All attempts to demonstrate flagella failed.

Symptoms: This organism causes a soft rot of the lower half of the beet. The crown and leaves are not affected with the exception of some of the outer leaves which may die. The rotted tissue is yellowish-gray in color and honey combed with pockets which are filled with a viscid, colorless, sour-smelling fluid. It is the parenchyma cells which are attacked. The vascular tissue is not rotted. The organism enters through wounds.

Hosts: (natural) *Beta vulgaris;* (artificial) *Allium cepa, Daucus carota, Hyacinthus orientalis, Ipomoea batatas, Musa sapientum, Pastinaca sativa.*

Geographical distribution: Nebraska, Colorado, Texas, Arizona.

Control: Beets should be grown on relatively dry ground. Growing on wet bottom land favors the development of the disease. Selection of resistant varieties seems to offer the best means of control.

Literature:

1903. Hedgcock, G. G., and H. Metcalf. Eine durch Bakterien verursachte Zuckerrübenkrankheit. Zeitschr. f. Pflanzenkr. **12**: 321–324, 1903. A preliminary account.

1904. Metcalf, H. *Bacterium teutlium* sp. nov. Centralb. f. Bakt. **13**: 28–30, 1904.

1904. Metcalf, H. A soft rot of the sugar beet (*Bacterium teutlium* Metcalf). Ann. Rept., Nebraska Agr. Exp. Sta., 17: 69–112, 1904.

1920. Smith, E. F. An introduction to bacterial diseases of plants, p. 474, 1920.

1930. Bergey's Manual of Determinative Bacteriology, p. 244, 1930 (3rd ed.).

Bacillus (?) alliariae Omori, 1896

Motile; 2.5–3.0 x 1.5μ; aerobic; round white colonies on agar; optimum temperature 13–26°C., minimum 8°C.; gelatin liquefied.

Symptoms: Lesions are at first small, black-brown depressions at the end or middle of the rhizome or at the internode between the main rhizome and a branch. The rot spreads from these points through the root to vascular tissue and may attack the petiole causing black spots or streaks.

Host: *Alliaria wasabi*.

Geographical distribution: Japan.

Control: Shade should be provided for the fields and they should be well drained. Only healthy seedlings should be used and they should be disinfected with wood ash (1 part ash to 7 parts water) for fifteen hours.

Literature:

1896. Hori, S. Rhizome-rot of Wasabi (*Alliaria wasabi* (Maxim) Prantl). Official Gazette of Japan 11, No. 3758: Jan. 1896. (Original not seen) Stapp (1928).

1896. Omori. On the bacterial disease of Wasabi. Official Gazette of Japan 17, no. 3763: p. 70, 1896. (Original not seen) Stapp (1928).

1914. Ideta, A. Handbook of plant diseases of Japan, p. 75–76, 1914. (In Japanese.)

1922. Poole, R. F. Bacterial root rot of horse-radish in New Jersey. Phytopath. 12: 49, 1922. (Abstract.)

1921. Poole, R. F. Horse-radish root rot investigations. Rep. Dept. Plant Path. New Jersey Agr. Coll. Exp. Sta. 1919–20: 610, 1921. Disease caused by a bacterium.

1923. Poole, R. F. Investigation of the horse-radish root rot. Ann. Rept. New Jersey Agric. Exp. Sta. for year ending June 30, 1922, 35: 560–561, 1923. Due to Bacterium producing either soft rot or a brownish fermenting decay. No organism named.

1928. Stapp, C. Schizomycetes (Spaltpilze oder Bakterien). In Sorauer's Handbuch der Pflanzenkrankheiten 2 (fünfte auflage): 121, 1928.

Bacillus amylovorus (Burrill) Trevisan, 1889

Motile by peritrichiate flagella; 0.7–1.0 x 0.9–1.5μ (L. R. Jones) 0.5–0.9 x 1.0–1.8μ (D. H. Jones); chains; no capsules; no spores; Gram negative; not acid fast; aerobic and facultative anaerobic; agar colonies circular, small, margins entire, more or less opalescent white, glistening, butyrous; prompt heavy clouding in beef bouillon or potato broth with slight granular pellicle; nitrates not reduced; gelatin slowly liquefied; no gas; milk curdled and more or less completely

digested; litmus partially reduced; indol production scanty or negative; acid from sucrose, glucose, lactose, glycerin; no ammonia; no hydrogen sulphide; no growth or slow growth in Uschinsky's solution; no growth in Cohn's; optimum temperature 30°C.; thermal death point 43.7°C. (L. R. Jones), 45°–50°C. (D. H. Jones), 45°–46°C. (E. F. Smith).

Synonymy:

Micrococcus amylovorus Burrill, 1882.

Micrococcus amylivorus Burrill, 1883. Burrill (1914) says the spelling *Micrococcus amylivorus* was a typographical error.

Bacterium amylovorus (Burrill) Chester, 1897.

Bacillus amylovorus (Burrill) DeToni, 1900.

Bacillus amylivorus (Burrill) Trevisan, 1913.

Bacterium amylovorum (Burrill) Serbinoff, 1916.

Erwinia amylovora (Burrill) Com. S. A. B., 1923.

Symptoms: The disease makes its appearance early in the season in the form of blossom blight and twig blight. Blossoms and leaves of infected twigs suddenly wilt, turn dark brown to black, shrivel and die and remain attached to the twigs. The bark of infected twigs becomes shrunken and dark brown to purplish, sometimes blistered with gummy exudate oozing out. The browned or blackened blighted branches and dead persistent leaves look as if scorched. The disease usually begins at the tip of the twig or in the blossoms and works downward by way of the bark parenchyma, killing the twig as it progresses, passing through petioles into the leaf blades and into the inner bark of larger branches and trunk which may be girdled and killed. Cankers on main limbs usually develop from infected twigs and sprouts. The bark is at first somewhat water-soaked and discolored, later brown to purplish. The bark blisters and cracks and exudate oozes to the surface. When the disease ceases to be active the diseased bark shrinks away from the healthy tissue. In the spring the disease may spread from exudate formed at the margins of these cankers. Infection enters the green fruit through wounds or peduncle, multiplies in the intercellular spaces and dissolves the middle lamella. The fruit turns black, shrivels, and takes on a mummified appearance. Fire blight, blossom blight, twig blight, canker blight, pear blight, collar blight.

Hosts: *Amelanchier canadensis*, *Amygdalus communis*, *Amygdalus persica*, *Aronia* sp., *Crataegus crusgalli*, *Crataegus oxyacantha*, *Crataegus oxyacantha* var. *splendens*, *Crataegus pyracantha*, *Cydonia japonica*, *Cydonia oblonga*, *Eriobotrya japonica*, *Fragaria* sp., *Malus baccata*, *Malus coronaria*, *Malus sylvestris*, *Mespilus germanica*, *Photinia* (*Heteromeles*) *arbutifolia*, *Prunus domestica*, *Prunus americana nigra*, *Prunus americana*, *Prunus armeniaca*, *Prunus avium*, *Prunus hortulana*, *Prunus nigra*, *Prunus simoni*, *Prunus triloba* var. *plena*, *Pyracantha coccinea*, *Pyrus amygdaliformis*, *Pyrus baccata*, *Pyrus balansae*, *Pyrus betulaefolia*, *Pyrus bretschneideri*, *Pyrus calleryana*, *Pyrus calleryana dimorphophylla*, *Pyrus canescens*, *Pyrus cordata*, *Pyrus coronaria*, *Pyrus communis*, *Pyrus cotinifolia*, *Pyrus elaeagrifolia*, *Pyrus fascicularis*, *Pyrus faurieri*, *Pyrus glabra*, *Pyrus heterophylla*, *Pyrus hondoensis*, *Pyrus koehnei*, *Pyrus longipes*, *Pyrus malifolia*, *Pyrus malus*, *Pyrus mamorensis*, *Pyrus michauxii*, *Pyrus nivalis*, *Pyrus ovoidea*, *Pyrus parviflora*, *Pyrus paschia*, *Pyrus persica*, *Pyrus phaeocarpa*, *Pyrus salicifolia*, *Pyrus serotina*, *Pyrus serrulata*, *Pyrus sinaica*, *Pyrus ussu-

riensis, Rosa sp., *Rubus strigosus, Rubus* sp., *Sorbus americana, Sorbus aucuparia* var. *lascinita, Spiraea vanhouttei.*

Geographical distribution: United States, Canada, Sicily, Italy, Germany, East Prussia, Russia, Transcaucasia, Turkestan, Japan, New Zealand.

Control: Prompt, severe pruning offers the best known means of control. For disinfecting tools and treating wounds due to pruning, Reimer (1920) recommends: 1 gm. cyanide of mercury, 1 gm. bichloride of mercury, in 500 cc. water. For control of young cankers Day (1924) recommends the removal of the outer dead bark and painting with bichloride of mercury and cyanide of mercury in a solution of one part water and three parts glycerin. Day (1927) recommends the following treatment: 1 lb. dry zinc chloride in 1 pint of a solvent composed of 1 gallon denatured alcohol, 1 pt. water, 3 oz. concentrated hydrochloric acid, applied on the unscraped bark over 10–12 inches above and below the canker. This has proved successful in checking canker on large branches, trunk and root crowns. *Pyrus ussuriensis, Pyrus ovoidea, Pyrus calleryana* and *Pyrus variolosa* are resistant to fire blight. *Pyrus ussuriensis* is worthless as stock because of its very slow growth. *Pyrus ovoidea* is the most promising rootstalk for southern Oregon. Reimer (1925) says the losses from trunk and root blight can be largely prevented in the newer orchards by planting a resistant variety like Old Home on a resistant rootstalk like *P. calleryana* or Ba Li Hsiang and top working these when three or four years old with the desired commercial variety. Reimer (1928) considers root blight the most serious phase of fire blight as the roots are the source of infection for much of the top blight. Infected roots should be removed in the fall or early spring.

Literature:

1801. Denning, W. On the decay of apple trees. (From a letter to Mr. Mitchell dated Dec. 22, 1793.) Trans. New York Soc. Prom. Agr. Arts and Manu., 2nd ed. rev., 1: 185–187, (part 2), 1801. This is the first printed record of the disease as it appeared on pear and quince. The author first observed it in the vicinity of the Hudson River, north of the Highlands in 1780.

1817. Coxe, W. A view of the cultivation of fruit trees, and the management of orchards and cider; with accurate descriptions of the most estimable varieties of native and foreign apples, pears, peaches, plums, and cherries cultivated in the middle states of America. Chapter 24: 174–176, 1817. The author uses the name "fire blight" for the first time and says it "frequently destroys trees in the fullest apparent vigour and health, in a few hours, turning the leaves suddenly brown, as if they had passed through a hot flame, and causing a morbid matter to exude from the pores of the bark, of a black ferruginous appearance." He notes varietal differences in susceptibility and states that pruning tends to make the trees more liable to the blight.

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1929. Miller, P. W. Studies of the fire blight of apple in Wisconsin. Journ. Agr. Res. **39**: 579, 621, 1929.

1929. Tullis, E. C. Studies on the overwintering and modes of infection of the fireblight organism. Michigan Agric. Exp. Sta. Tech. Bul. 97: 1–32, 1929.

Bacillus ananas Serrano, 1928

Motile by four to eight peritrichiate flagella; 0.6 x 0.9μ; chains; capsules; no spores; Gram negative; not acid fast; facultative anaerobe; potato glucose agar colonies primuline yellow, circular, with tendency to spread or run, glistening, convex to umbilicate; fragile yellow pellicle on beef bouillon; growth on potato plugs copious, glistening, moist, spreading, primuline yellow to aniline yellow, with no discoloration of plug; gelatin liquefied; milk coagulated; litmus reduced; no gas; acid from sucrose, lactose, glucose, glycerin; diastatic action present; hydrogen sulphide and ammonia produced; no indol; nitrates reduced; optimum temperature 30°–35°C.; maximum 45°C.; minimum 6°C.; thermal death point 56°–57°C.

Synonymy: *Erwinia ananas* Serrano, 1928.

Symptoms: This organism causes a brown rot of the fruitlets of pineapple. Slight infection is not apparent externally but with severe infections the ripening color may be distinctly dull and marked with minute purplish dots, and the fruit is unusually hard. The organism enters through floral parts or cracks or slits in the eye cavity. Young infections are brown, turning to dusky brown and finally bone brown discoloration of one or more fruitlets. These discolorations may be limited to the placental area or may involve the entire fruitlet, occasionally extending to the fibrovascular bundles of the core. Affected tissues become dry and hard. The disease develops only during the ripening of the fruit and does not seem to spread after that time.

Hosts: *Ananas sativus*, *Saccharum officinarum*.

Geographical distribution: Luzon, Philippine Islands.

Control: Individual plants varied greatly in resistance to the disease.

Literature:

1898. Tryon, H. Fruitlet core-rot of pineapple. Queensland Agr. Journ. **3**: 458–467, 1898. Serrano says this disease in many ways resembles the disease under discussion.

1926. Barker, H. D. Fruitlet black rot disease of pineapple. Phytopath. **16**: 359–363, 1926. A pale yellowish bacterium was isolated and reproduced the disease in Haiti. Serrano says this disease appears to be quite similar to the Philippine disease if not identical with it.

1928. Serrano, F. B. Bacterial fruitlet brown-rot of pineapple in the Philippines. The Philippine Journal of Science **36**: 271–300, 1928.

Bacillus araliavorus Uyeda, 1909

Motile by six to twelve peritrichiate flagella; 0.7–0.9 x 1.8–2.0μ; no spores; no chains; Gram negative; aerobic; grayish white on agar; no gas; gelatin not liquefied; milk not coagulated; no acid with litmus milk; diastatic action on

starch; nitrates reduced; no hydrogen sulphide; indol produced; optimum temperature 25°–28°C.; maximum 40°C.; thermal death point 55°C.

Symptoms: The disease is described as a red rot of stems and roots of ginseng. It is first evident as light brown to red brown or black brown spots on the surface of the root. As these spots enlarge they are round to irregular or may girdle the root. The diseased tissue becomes sunken and shrinks away from the healthy tissue. The inside of the root may decay leaving the cortex intact or the disease may start in the rootlets which rapidly decay. The leaves and stems show no signs of the disease in the early stages but as it progresses the stems become stunted and the leaves show yellow to red brown spots.

Hosts: *Panax* sp., *Panax quinquefolium.*

Geographical distribution: Korea, Japan.

Control: The writer recommends—that fields be well drained; soil treatment with 5 per cent formalin; thorough cultivation of the soil; steam sterilization of seed beds; spraying of plants with Bordeaux mixture before transplanting; extermination of insects which injure the plants; removal from the field of infected plants and surrounding soil.

Literature:

1909. Uyeda Yeiziro. Die Roth-fäule von Ginseng verursachtet durch *Bacillus araliavorus* und einige anderen bakterien Arten. Bul. Imperial Agr. Exp. Sta. Tokyo, 35: 61–104, 1909. Also in Miyabe-festschr., 75–113, 1911.

1910. Rankin, W. H. End or red rot of ginseng. (*Bacillus araliavorous* Uyeda) Special Crops, (n. s.) 9 (No. 94): 356, 1910.

1914. Ideta, A. Handbook of the plant diseases of Japan, pp. 30–32, 1914. (In Japanese.)

1915. McClintock, J. A. Report of ginseng disease investigations conducted in Michigan in 1913 and the Spring and Summer of 1914. Proc. 11th Conv. Michigan State Assoc. Ginseng Growers, pp. 17–22, 1915.

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Bacillus aroideae Townsend, 1904

Motile by two to eight peritrichiate flagella; 0.5 x 2.0–3.0μ (Townsend), 0.7–1.0 x 1.5–5.0 (Harding and Morse); no spores; chains; no capsule; Gram negative; facultative anaerobe; agar colonies round to amoeboid, glistening, white to slightly opalescent; gelatin liquefied; milk curdled and slightly peptonized with formation of gas; nitrates reduced; no indol (Town.), indol produced (Harding and Morse); good growth in Uschinsky's solution; acid without gas from dextrose, maltose, lactose, galactose, sucrose, glycerol, mannitol; hydrogen sulphide produced; slight diastatic action; optimum temperature 35°C.; maximum 41°C.; minimum below 9°C.; thermal death point 50°C.

Synonymy:

Erwinia aroideae (Townsend) Holland, 1923.

Bacterium aroideae (Townsend) Stapp, 1928.

Harding and Morse (1909) considered *Bacillus aroideae* and *Bacillus carotovorus* as members of a single species. Smith (1920) says "I think *Bacillus aroideae* and *Bacillus melonis* are identical." Bergey (1923) quotes Harding and Morse. Massey (1924) as a result of cultural and inoculation tests, concluded that "*Bacillus carotovorus* and *Bacillus aroideae*, though closely related, should be maintained as separate species." Link and Taliaferro (1928) found *Bacillus aroideae* and *Bacillus carotovorus* distinct serologically.

Symptoms: This organism causes a soft rot of corm, petiole, and flower stalk. The disease usually begins on the upper portion of the corm at or near the surface of the ground and progresses upward into leaf and flower stalks or down into the corm and roots. The healthy part of the corm is firm and white, the diseased part soft, brown and watery. The disease may start in the edge of the petiole which becomes slimy without at once losing its green color. As the disease progresses toward the inside of the petiole and interferes with the transfer of materials through the vascular system, the edges of the leaves turn brown. Brown spots appear on the leaf blade and finally the whole leaf dies. The leaf may rot off at the base and fall over before losing its green color. When the flower stalk is attacked the flower turns brown and the stalk falls over. When the disease progresses through the corm to the roots, the roots become soft and slimy inside the epidermis and finally dry up. The corm may rot so rapidly that the plant will fall over without showing any other indications of disease. When conditions are unfavorable the diseased parts of the corm may dry down to sunken dark colored spots which remain dormant and are the means of carrying over the disease from season to season and from place to place. The organism enters the intercellular spaces and dissolves the middle lamella. On tomatoes infection takes place on green fruit through growth cracks, insect wounds, or sunscald. Infected tissue is at first water-soaked and depressed but soon becomes opaque with a narrow water-soaked margin, wrinkled and often cracked. The entire fruit becomes a soft, watery, colorless, decayed mass in 3–10 days. Rotted fruit often burst and there is an offensive odor.

Hosts: *Allium cepa*, *Apium graveolens*, *Beta vulgaris*, *Brassica oleracea capitata*, *Brassica oleracea caulo-rapa*, *Brassica oleracea botrytis*, *Brassica rapa*, *Capsicum annuum*, *Cucumis melo*, *Cucumis sativus*, *Daucus carota*, *Hyacinthus orientalis*, *Ipomoea batatas*, *Iris versicolor*, *Lycopersicum esculentum*, *Nicotiana tabacum*, *Pastinaca sativa*, *Pelargonium zonale*, *Raphanus sativus*, *Solanum melongena*, *Solanum tuberosum*, *Tragopogon porrifolius*, *Zantedeschia aethiopica*, *Zantedeschia elliottiana*.

Geographical distribution: General throughout the United States, England, Japan.

Control: Townsend (1904) recommended selection of healthy corms for planting and changing the soil in the plant beds every third or fourth year. Ritzema Bos (1914) recommended the destruction of diseased plants and disinfection of the soil with lime. Fromme (1922) and Wingard (1924) found that the disease could be appreciably reduced by spraying tomatoes with soap Bordeaux (4 pounds of bluestone, 2 pounds rosin fish-oil soap, 3 pounds quicklime, 50 gallons water). For control of soft rot of arum, Bewley (1925) recommends that at the end of the resting period the soil be removed from the corms, adventitious roots scraped off, decayed parts cut out, corms thoroughly washed in water and then placed

for an hour in a 2 per cent solution of formaldehyde (1 part 40 per cent formaldehyde in 49 parts water) and potted at once.

Literature:

1894. Halsted, B. D. Diseases of calla. New Jersey Agr. Exp. Sta. Rept. for 1893: 399–401, 1894. Bacteria were found in abundance in decaying callas received from California.

1900. Selby, A. D. A condensed handbook of the diseases of cultivated plants in Ohio. Ohio Agr. Exp. Sta. Bul. 121: 21, 1900. Revis. ed.: A brief handbook of the diseases of cultivated plants in Ohio. Bul. 214: 382, 1910.

1904. Townsend, C. O. A soft rot of calla lily. U. S. Dept. Agr., B. P. I. Bul. 60: 47 pp., 1904.

1910. Harding, H. A., and W. J. Morse. The bacterial soft rots of certain vegetables. Part I. The mutual relationships of the causal organisms. Vermont Agr. Exp. Sta. Bul. 147: 243–279, 1910.

1917. Bos, J. Ritzema. Institut voor Phytopath. ter Wageningen. Verslag. over onderzoekingen usw. 1914: 14, 1917.

1920. Smith, E. F. An introduction to bacterial diseases of plants, pp. 240, 688, 1920.

1921. Bewley, W. F. A bacterial disease of the Arum. Gard. Chron. III, **69**: 152, 1921.

1922. Bewley, W. F. Soft rot of the Arum. Ann. Rept. Exp. and Res. Sta., Cheshunt, Herts. 7 (1921): 39–40, 1922.

1922. Fromme, F. D. Experiments in spraying and dusting tomatoes. Virginia Agr. Exp. Sta. Bul. 230: 1–15, 1922.

1923. Bergey's Manual of Determinative Bacteriology, p. 171, 1923.

1924. Massey, A. B. A study of *Bacillus aroideae*, Townsend, the cause of a soft rot of tomato, and *B. carotovorus* Jones. Phytopath. **14**: 460–477, 1924.

1924. Wingard, S. A. Bacterial soft-rot of tomato. Phytopath. **14**: 451–459, 1924.

1925. Bewley, W. F. Soft rot of the arum. Ann. Rept. Exp. and Res. Stat., Cheshunt, Herts. **10**: 74–75, 1925.

1925. Brookes, R. St. John, K. Nain, and M. Rhodes. The investigation of phytopathogenic bacteria by serological and biochemical methods. Journ. Path. and Bakt. **28**: 203–209, 1925. See *Bacillus carotovorus*.

1926. Burgwitz, G. K. (Watery rot of tomato fruits.) Morbi Plantarum Leningrad **15**: 105–116, 1926. (Russian with German summary.) Similar to that described by Wingard from Virginia but the organism differs in certain respects from *Bacillus aroideae*.

1928. Brierley, P. Pathogenicity of *Bacillus mesentericus*, *B. aroideae*, *B. carotovorus*, and *B. phytophthorus* to potato tubers. Phytopath. **18**: 819–837, 1928.

1928. Link, Geo. K. K., and W. H. Taliaferro. Further agglutination tests with bacterial plant pathogens. II. Soft-rot group: *Bacillus aroideae* and *B. carotovorus*. Bot. Gaz. **85**: 198–207, 1928.

1928. Stapp, C. Schizomycetes (Spaltpilze oder Bakterien). In Sorauer's Handbuch der Pflanzenkrankheiten, 2 (fünfte auflage): 41–43, 1928.

Bacillus (?) asteracearum Pavarino, 1912

0.5–0.6 x 5.0–6.0μ; chains; Gram positive when the decolorization is not too prolonged; aerobic and facultative anaerobe; agar colonies regular, with entire margins, straw yellow more intense toward the center; gelatin liquefied; gelatin colonies irregular with notched margins, pale yellow; on glycerine agar growth slightly raised, glistening, lemon yellow; slight clouding of bouillon; abundant growth on potato with a color tending toward rose and with a shagreene aspect in the dry part.

Symptoms: The disease first manifests itself on the lower surfaces of the leaves as scattered, punctiform spots, which increasing, become round or more or less elongated, sunken and ochraceous in color, finally confluent and the entire leaf blade shrivels and drys up. The disease spreads up the stalk to the flowers which also turn brown and wither.

Host: *Aster chinensis.*

Geographical distribution: Pavia, Italy.

Literature:

1912. Pavarino, G. L. Batteriosi dell' *Aster chinensis* L.: *Bacillus asteracearum* n. sp. Atti R. Accad. Naz. Lincei Rend. Cl. Sci. Fis., Mat. e Nat. 5 ser. 21: 1 sem., 544–546, 1912.

Bacillus (?) brassicaevorus Delacroix, 1905

Motile but flagella not demonstrated; 0.5–0.75 x 1.25–1.75μ; chains; no spores; Gram negative; fluorescent to dirty white on agar, and gelatin, later somewhat brown, round and convex; gelatin not liquefied; no gas; bouillon clouded with thin pellicle. The organism is very imperfectly described. It is not certain that he was working with pure cultures.

Synonymy: Griffon in 1909, without experimental proof, says he considers *Bacillus brassicaevorus*, = *B. fluorescens putridus* Flügge. Delacroix and Maublanc in 1916 quote Griffon to this effect. See *Bacillus fluorescens putridus* Flügge. Szymanek (1926) says the fluorescent bacteria cannot be considered as pathogenic but only enter through insect wounds.

Symptoms: This organism is said to cause a rot of cabbage.

Hosts: *Brassica oleracea capitata, Brassica oleracea botrytis.*

Geographical distribution: France near Douai.

Control: Diseased plants should be destroyed and a long crop rotation practiced.

Literature:

1905. Delacroix, G. Sur une pourriture bacterienne des choux. Compt. Rend. Acad. Sci. (Paris) 140: 1356–1358, 1905.

1907. Quanjer, N. M. Neue kohlkrankheiten in Nord-Holland (Dreherzkrankheit, Fallsucht und Krebs). Zeitschr. f. Pflanzenkr. 17: 258–267, 1907. He speaks of *Contarinia torquens* as causing a rot.

1909. Griffon, Ed. Sur le rôle des bacilles fluorescents de Flügge en pathologie végétale. Compt. Rend. Acad. Sci. (Paris) 149: 50–53, 1909.

1916. Delacroix, G., et A. Maublanc. Maladies des plantes cultivees. 2: 42, 1916.

1925. Géray. La pourriture bactérienne du chou-fleur. Journ. d'Agric. Prat. 89: 501–502, 1925.

1926. Szymanek, J. Une maladie du chou-fleur du nord de la France. Rev. Path. Vég. et Ent. Agric. 13: 259–261, 1926. In all the plants examined larvae of *Contarinia torquens* were found in the leaves and it is thought that the bacteria (*Bacillus brassicaevorus*) are not true pathogens but are introduced through wounds made by these insects.

Bacillus (?) bussei Migula, 1900

Motile; 0.7–0.8 x 1.5–1.75μ; chains; no spores; whitish, slimy colonies on agar; round, pale yellow, later wax like on gelatin; gas in stab cultures; gelatin not liquefied; acid and gas from glucose.

Migula gave this name to Busse's *Bacillus B*. Busse states that as a result of his successful inoculation and reisolation experiments this should be considered a true bacterial disease. But he makes the reservation that it will first be proved by further experiments. Stapp 2: 90, 1928, states that this reservation is very applicable. The organism is motile but flagella were not stained.

Symptoms: The first symptom of the disease is a red brown and later a black brown discoloration of fibro-vascular bundles following the formation of a thick gummy liquid filled with bacteria. The beet shrivels, contains little juice and a short time after harvest the root begins to turn brown. In advanced stages spots of different size become soft and brown and give off a slimy brown liquid, strongly acid but without characteristic odor or taste.

Host: *Beta vulgaris*.

Geographical distribution: Germany.

Literature:

1897. Busse, W. Bacteriologische studien über die "Gummosis" der Zuckerrüben. Zeitschr. f. Pflanzenkr. 7: Heft. 2, 65–76, Heft. 3, 149–155, 1897.

1900. Migula, W. System der Bakterien 2: 779, 1900.

1928. Stapp, C. Schizomycetes (Spaltpilze oder Bakterien). In Sorauer's Handbuch der Pflanzenkrankheiten. 2 (fünfte auflage): 87–91, 1928.

Bacillus (?) cacticidus Johnston and Hitchcock, 1923

Actively motile (nothing said of number or arrangement of flagella); 0.8 x 1.3μ; no spores; no capsules; Gram negative; aerobic-facultative anaerobic; agar colonies dirty white inclining to yellow, round, raised, glistening; acid from glucose, sucrose, mannit, salicine; no acid from maltose, lactose, dulcite, arabinose; acid curd in milk; abundant gas production in prickly pear decoction; optimum temperature 28°–30°C.

Symptoms: The disease first appears as rounded, blackish areas with bright purple margins separated from healthy tissue by a chlorotic zone. The paren-

chyma under the lesion disintegrates into a dark brown slimy, fetid liquid. The cuticle may become slightly sunken or may bulge out due to the gas pressure below. The disease progresses only within the infected segment by breaking down the parenchyma cells. If the products of putrefaction escape only a dried cuticle remains about the vascular strands. Similar lesions occur on the stems but progress slowly. Artificial infection was obtained only by wounding and is naturally transmitted by insects.

Hosts: *Cucumis melo, Cucurbita maxima, Cucurbita pepo* var. *ovifera, Opuntia aurantiaca, Opuntia ficus-indica, Opuntia inermis, Opuntia mesacantha, Opuntia monacantha, Opuntia stricta, Opuntia tomentella, Opuntia tomentosa.*

Geographical distribution: Miami, Florida.

Literature:

1923. Johnston, T. H., and L. Hitchcock. A bacteriosis of prickly pear plants (*Opuntia* sp.). Trans. and Proc. Roy. Soc. So. Australia 47: 162–164, 1923.

Bacillus (?) capsici Pavarino e Turconi, 1918

Nothing said of motility or flagella; 0.8–1.0 x 1.5–3.0μ; spores; chains; Gram positive if the decolorizing is not too prolonged; gray white on agar; facultative anaerobe; gelatin liquefied; acid coagulation of milk; gelatin colonies gray-white, slightly raised, regular in outline; growth on potato grayish yellow, becoming brown; broth cultures greenish yellow with a pellicle.

Synonymy: Stapp, 1928, says it remains to be demonstrated whether and how much this agrees in etiology with *Pseudomonas vesicatoria.*

Symptoms: This organism causes a characteristic wilting of the leaves which hang down along the branches and main stalk, cankers on the roots, and irregular brown more or less depressed spots on the stalk. These spots extend to the branches, leaf peduncles and fruit pedicels on which circular depressions are formed. Irregular brown spots occur on the fruit. It causes a browning of the cambium and often of the wood beneath.

Host: *Capsicum annuum.*

Geographical distribution: Italy.

Literature:

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1928. Stapp, C. In Sorauer's Handbuch der Pflanzenkrankheiten 2(5): 262, 1928.

Bacillus carotovorus L. R. Jones, 1901

Motile by two to five peritrichiate flagella; 0.6–0.9 x 1.5–5.0μ; no spores; no capsules; chains; aerobic and facultative anaerobic; Gram positive (Jones), Gram negative (Harding and Morse); not acid fast (Stapp 1928); nutrient agar colonies round, raised, smooth, gray-white, glistening, with entire margins which

if the colonies are thinly sown may be more or less irregular and may send out finger-like branched projections; beef bouillon clouds rapidly with formation of a very thin imperfect pellicle; growth in Uschinsky's solution abundant with delicate pellicle and copious precipitate; growth on steamed potato cylinders slightly raised, glistening, smooth, cream white, with slight evolution of gas; diastatic action present; slight indol production, (no indol, Stapp 1928); gelatin slowly liquified; nitrates reduced; milk curdled but not cleared; litmus and methylene blue reduced; gas from dextrose, sucrose, lactose, mannit, muscle sugar; no gas from glycerin or potato juice; Stapp (1928) gives acid from glycerin and inosite, acid and gas from mannite, arabinose, xylose, fructose, rhamnose, raffinose, gas from hesperonal-calcium, acid from amygdalin, arbutin, coniferin, salicin; optimum temperature 25°–30°C.; minimum above 4°C.; maximum 38°–39°C., Stapp 39°–40.8°C.; thermal death point 51°C., Stapp 48°–49°C.

Synonymy:

Bacillus oleraceae Harrison, 1902.
Bacillus omnivorus van Hall, 1902.
Bacillus apiovorus Wormald, 1913.
Erwinia carotovora (L. R. Jones) Holland, 1923.
Erwinia oleraceae (Harrison) Bergey et al., 1923.
See *Bacterium destructans*, *Bacillus hyacinthi septicus*, *Bacterium iridis*.

Harding and Morse (1909) state that "*Bacillus omnivorus* van Hall and *Bacillus oleraceae* Harrison are clearly identical with *Bacillus carotovorus* and there is no further occasion for continuing to recognize them as distinct species." Smith (1920) says "Forms apparently identical with *Bacillus carotovorus* are *Bacillus oleraceae* Harrison on cauliflower and *Bacillus omnivorus* van Hall on iris." Richardson (1922–23) found that the Canadian iris rot was due to *Bacillus carotovorus*. Wormald (1917) after comparing cultures of the two organisms concluded that *Bacillus apiovorus* was only at most a variety of *Bacillus carotovorus*. Smith (1920) says "I have been inclined to think that *Bacillus carotovorus* and *B. phytophthorus* are not strictly identical, but further comparisons are necessary." Brooks (1925) found that *Bacillus carotovorus*, *B. phytophthorus*, and *B. solanisaprus* show a distinct serological relationship as well as identical reactions with sugars, milk and gelatin. Berridge (1926) states that serological and chemical tests show that *B. carotovorus*, *B. solanisaprus* and *B. phytophthorus* are different organisms although closely related. Lacey (1926) found that cultural, pathological and serological tests show a close relationship between *B. carotovorus*, *B. solanisaprus* and *B. phytophthorus* but that there are sufficiently marked and constant differences to warrant their being kept as separate species. See Chupp, 1925. Stapp (1928) found constant serological differences between *B. phytophthorus* and *B. carotovorus*. He found *B. carotovorus* and *B. solanisaprus* identical serologically. He proposes to include *B. carotovorus* in a "*B. phytophthorus* group."

Symptoms: This organism causes a rapidly progressing soft wet rot of roots, rhizomes, fruits and fleshy stems of vegetables and other plants. It enters through wounds, penetrates the intercellular spaces, dissolves the middle lamella forming large cavities in the roots. There is often a distinct brown stain in the affected parts of the carrot. Roots attacked by this organism often become within a few days so soft and pulpy from a general destruction of the middle

lamellae as not to be able to sustain their own weight. The moist interior of the root usually rots more quickly than the dryer cortical parts. The advancing margin of decay is usually quite distinct. The decaying surface may crack open and may be covered by a delicate moist gray bacterial film or by drops of fluid which are cloudy with bacteria. The tips of iris leaves wither, the basal portion becomes water-soaked and the water-soaking progresses up the leaf until the leaf and shoot collapse. A dirty cream colored bacterial ooze exudes from the base of the shoot. In the rhizome a darkened area appears around the point of infection. This spreads and the young part of the rhizome becomes soft and slimy with a strong odor. The soft rotted tissue dries. The entire center of the rhizome disintegrates but the epidermis remains unchanged.

Hosts: *Allium cepa, Alocasia macrorrhiza, Amorphophallus simlense, Apium graveolens, Asparagus officinalis, Brassica campestris, Brassica juncea, Brassica oleracea, Brassica oleracea botrytis, Brassica oleracea capitata, Brassica oleracea caulo-rapa, Brassica oleracea gemmifera, Brassica pekinensis, Brassica rapa, Caladium schomburghii, Capsicum annuum, Cichorium intybus, Colocasia esculenta, Cucumis sativus, Cucumis melo, Cynara scolymus, Daucus carota, Helianthus tuberosus, Hyacinthus orientalis, Iris florentina, Iris germanica, Iris versicolor, Iris verna, Lactuca sativa, Lycopersicum esculentum, Nicotiana tabacum, Pastinaca sativa, Pelargonium zonale, Phaseolus coccineus, Phaseolus vulgaris, Radicula armoracia, Raphanus sativus, Rheum rhaponticum, Solanum melongena, Solanum tuberosum, Tragopogon porrifolius, Viola* sp., *Xanthosoma sagittifolium, Zantedeschia aethiopica.*

Geographical distribution: Widespread in United States and Canada; Bermuda, Maurice, Great Britain, Holland, France, Japan, Philippines.

Control: Chupp (1925) recommends: thorough disinfection of storage house by washing or spraying with formaldehyde (1 pint in 10 gallons of water) or copper sulfate (1 pound in 5 gallons of water); storage of sound, dry tubers in a small amount of straw or sand to prevent contact and in well ventilated storage rooms where the temperature is near 32°F.; long rotations with immune crops such as corn, grasses, cereals.

Hoare (1925) recommends, for iris, cutting away of diseased parts and disinfection with permanganate of potash or removing and burning of the entire plant. Application of lime and superphosphate are said to reduce the disease.

Literature:

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1901. Jones, L. R. A soft rot of carrot and other vegetables caused by *Bacillus carotovorus* Jones. Vermont Agr. Exp. Sta. Report 13: 299–332, 1901.

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1909. Jones, L. R. II. Pectinase, the cytolytic enzyme produced by *Bacillus carotovorus* and certain other soft rot organisms. Vermont Agr. Exp. Sta. Bul. 147: 281–360, 1909. Also in New York (Geneva) Agr. Exp. Sta. Tech. Bul. 11: 289–368, 1909.

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1918. Bennett, C. W. Soft rot of pepper caused by *Bacillus carotovorus*. Rep. Michigan Acad. Sci. 20: 351–352, 1918.

1918. Coons, G. H. The soft rot of hyacinth. Michigan Acad. Sci. Rept. 20: 353–354, 1918. He has repeatedly isolated an organism from rotting hyacinths which readily rots carrot and corresponds with the characters of that organism.

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1919. Daumézon, G. Sur une maladie bactérienne de la carotte. Ann. Serv. Epiph. 6: 327–330, 1919 [1920]. Organism probably identical with *Bacillus carotovorus* of Jones.

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Bacillus citrimaculans Doidge, 1917

Motile by five to ten peritrichiate flagella; 0.45–0.7 x 1.0–4.0μ; no spores; capsules; Gram positive; not acid fast; aerobic, facultative anaerobic; nutrient agar colonies subcircular, yellow, with dense grumose center; gelatin liquefied; blood serum not liquefied; growth on potato thin, spreading, primuline yellow to mustard yellow, glistening; milk curdled but not cleared; no growth in Cohn's solution; characteristic growth in Uschinsky's; no gas; acid from dextrose, levulose, galactose, maltose, sucrose, mannit; no acid from lactose, glycerin, dextrin, starch; nitrates reduced with evolution of gas; indol produced; optimum temperature 35°C.; maximum 43°C.; thermal death point 62°C.

Symptoms: Fruit lesions are sunken, discolored, leathery, round spots 1–10 millimeters in diameter which may coalesce to form yellow to brown irregular blotches with more or less concentric brown rings on a lighter ground. With age they become light to blackish brown with reddish borders. The pulp below the discolored rind becomes dry and brown with a peculiar taste and odor. These spots are the starting points for fungus infections. Stems are attacked around the leaf bases. "An area of about 6–8 mm. in diameter becomes water-soaked in appearance, the petiole becomes involved and sometimes the basal part of the leaf, and the leaf falls. The infection then spreads to the branch in the leaf axil, surrounds it at the base and it withers and dries up." Stem lesions turn brown and are slightly sunken. Gum oozes from severed leaf bases in the spring. Dark brown spots with yellowish borders occasionally occur in the leaf tissue and fall out leaving holes. This is a disease of the parenchyma. Infection in the majority of cases takes place through wounds.

Hosts: (natural) *Citrus limonia, Citrus sinensis;* (artificial) *Citrus aurantifolia, Citrus grandis, Citrus medica.*

Geographical distribution: South Africa, Western Province.

Control: No control measures have been recommended except improvement in sanitation in the orchard.

Literature:

1917. Doidge, Ethel M. A bacterial spot of citrus. Ann. Appl. Biol. **3**: 53–81, 1917. On page 78 is a table of comparison of this organism with *Bact. citriputeale* and *Pseud. citri.* The author found that the serum of a rabbit inoculated with this organism agglutinated the homologous strains.

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1926. Fawcett, H. S., and H. A. Lee. Citrus diseases and their control, pp. 450–453, 1926.

Bacillus coli (Escherich) Migula, 1900

Motile by several peritrichiate flagella; 0.5 x 1.0–2.0μ; chains; no spores; Gram negative; aerobic; gelatin not liquefied; gelatin colonies opaque; moist, grayish-white, entire; agar colonies white to yellowish white, entire to undulate, moist, spreading; growth on potato abundant, grayish to yellowish-brown; milk curdled without subsequent digestion; acid and gas from dextrose, levulose, maltose, galactose, arabinose, raffinose, lactose, mannitol, sorbitol, dulcitol, salicin, dextrin; indol produced; nitrates reduced; optimum temperature 37°C.; thermal death point 56°–57°C.

Synonymy:

Bacterium coli commune Escherich, 1886.
Bacillus coli communis (Escherich) Sternberg, 1892.
Bacterium coli (Escherich) Lehmann and Neumann, 1896.
Escherichia coli (Escherich) Castellani and Chalmers, 1919.

Johnston (1912) came to the conclusion that coconut bud rot in the West Indies was due to a bacterium similar to *Bacillus coli.* Reinking (1919) found that coconut bud rot in the Philippines was due to *Phytophthora faberi* and that bacteria were unable to cause disease in uninjured trees. Ashby (1925) found

two coconut bud rots in the West Indies, one fungus and one bacterial. Tucker (1925) in Porto Rico isolated an organism resembling *B. coli* from diseased buds but the results of his inoculations were negative. He reproduced the disease with *Phytophthora faberi* with or without wounding. Stapp (1928) states that it remains to be determined whether coconut bud rot is due to bacteria or fungi or both.

Symptoms: This organism is said to cause bud rot of coconut. "The early symptoms are the yellowing and falling of the leaves and the dropping of immature nuts. Eventually the middle folded leaves bend over and the entire heart of the crown is involved in a vile-smelling soft rot." This organism is also said to cause soft rot of potato at high temperatures (Laurent 1899, Serbinoff 1915); soft rot of poppy (Laurent 1899, Foex 1915); soft rot of onion (Giampietro 1911); a rot of hyacinth (Gerretsen 1920); and a stem end and center rot of tomato (Brown 1926).

Host: *Cocos nucifera.*

Geographical distribution: West Indies. The bud rot probably occurs in all tropical countries.

Literature:

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1906. Petch, T. Bud rot of the coconut palm. Circ. and Agr. Journ. Roy. Bot. Gard. Ceylon 3: 223–226, 1906.

1908. Copeland, E. B. Bud rot of the coconut. Philippine Agr. Rev. 1: 210–220, 1908.

1911. Giampietro, A. W. Un marciume delle cipolle dovuto ad un batterio: *Bacillus coli.* (Nota preliminare.) Rivista di Patologia Vegetale 5: 49–52, 1911. He found *B. coli* and *B. cepivorus* to be identical.

1911. Johnston, J. R. Is *Bacillus coli* ever a plant parasite? Phytopath. 1: 97–99, 1911. The author gives a summary of isolation and inoculation work with *B. coli* on coconut palm and concludes that this organism is the cause of bud rot.

1912. Johnston, J. R. The history and cause of coconut bud rot. U. S. Dept. Agric., B. P. I. Bul. 228: 9–163, 1912.

1912. Morstatt, H. Bericht überein Reise nach Indien und Ceylon. Der Pflanzer 8: 461, 1912.

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1915. Rogers, L. A., W. M. Clark and A. C. Evans. The characteristics of Bacteria of the colon type occurring on grains. Journ. Infect. Dis. **17**: 137–159, 1915.

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1916. Johnston, J. R. Causa de la enfermedad llamada pudricion del cogollo del cocotero. Cuba Estac. Exp. Agron. Bol. **27**: 106 pp., 1916. Organism practically identical with *Bacillus coli*.

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1919. Doidge, E. M. The rôle of bacteria in plant diseases. So. African Journ. Sci. **16**: 65–92, 1919. Bud rot in Portuguese East Africa has been shown by Pole Evans to be due to *B. coli*.

1919. Reinking, O. A. Philippine plant diseases. Phytopath. **9**: 120–121, 1919.

1919. Reinking, O. A. *Phytophthora faberi* Maubl. The cause of coconut bud rot in the Philippines. The Philippine Journ. of Science **14**: 131–150, 1919. The results of his bacteriological work indicate that while bacteria (*Bacillus coli* (Esch.) Mig.) are always present and are a factor in destroying weakened tissues, they cannot account for the initiation of the disease or its prevalence and rapid spread.

1920. Gerretsen, F. C. Die Bakterien der Coli-aerogenes-gruppe als Erreger von Pflanzenkrankheiten. Zeitschr. f. Pflanzenkr. **30**: 223–227, 1920. He isolated an organism from hyacinths and claims infection from pure culture inoculation after 40–60 days. The organism has the No. 222.111.301 S.A.B. and belongs to the colon bacillus group but has lost its power of gas production in passing through the plant. (Abstr. by Güssow.)

1920. Smith, E. F. An introduction to bacterial diseases of plants, p. 54, 1920. "According to Reinking (The Philippine Journal of Science, Vol. XIV, Jan., 1919, pp. 131–151) the coconut bud-rot of the Philippines is due to *Phytophthora faberi* Maubl., *Bacillus coli* and a schizomycete resembling *B. coli* isolated from the rotting palm bud may aggravate the rot but cannot initiate it except under very favorable conditions of moisture and previous injury."

1921. Ashby, S. F. Relation between cacao pod rot and coconut bud rot. Agricultural News, Barbados, **20**: 318, 1921. Cross inoculation experiments with *Phytophthora faberi* Maublanc indicate that the cacao phytophthora does not appear to attack the coconut and that cacao pods cannot be rotted by the form from the bud rot of the coconut. *Phytophthora faberi* from coconut caused coconut bud rot.

1921. Carment, A. G. Coconut bud rot disease. Agr. Circ., Dept. Agric. Fiji, 2: 94–95, 1921.

1921. Lindau, G. Schizomycetes (Spaltpilze). In Sorauer's Handbuch der Pflanzenkrankheiten. 4 aufl., 2: 42–43, 1921.

1922. Reinking, O. A. Coconut bud rot in the Philippines. Phytopath. 12: 46–47, 1922.

1922. Sharples, A., and J. Lambourne. Observations in Malaya on bud-rot of coconuts. Ann. Bot. 36: 55–70, 1922.

1923. Bergey's Manual of Determinative Bacteriology, p. 196, 1923.

1923. Reinking, O. A. Comparative study of *Phytophthora faberi* on coconut and cacao in the Philippine Islands. Journ. Agr. Res. 25: 267–284, 1923.

1924. Bryce, G. Coconut diseases. Bud rot. Dept. Agr. New Guinea, Leafl. 7: 2 p., 1924.

1925. Ashby, S. F. Bud rots of the coconut palm in the West Indies. Rept. Imper. Bot. Conf. London 1924: 153–158, 1925. There are two bud rots—one fungus, one bacterial.

1925. Butler, E. J. Bud rot of coconut and other palms. Rept. Imper. Bot. Conf. London 1924: 145–153, 1925.

1925. Nowell, W. Coconut bud-rot in Trinidad. Rept. Imper. Bot. Conf. London 1924: 161–162, 1925.

1925. Tucker, C. M. Coconut bud rot experiments in Porto Rico. Science 61: 186–187, 1925.

1926. Brown, N. A. A stem-end and center rot of tomato caused by various unrelated organisms. Journ. Agric. Res. 33: 1009–1024, 1926.

1928. Stapp, C. Bakteriosen der Palmen. In Sorauer's Handbuch der Pflanzenkrankheiten, 2 (fünfte auflage): 40–41, 1928. He says it seems reasonably certain that coconut bud rot is a parasitic disease. Whether it is due to bacteria or fungi remains still to be determined. Perhaps Ashby (1925) is right that there are two different bud rots, one fungus and the other bacterial.

Bacillus croci Mizusawa, 1923

Motile by two to four peritrichiate flagella; 0.6–1.1 x 1.2–3.2μ; chains; no capsules; no spores; Gram negative; not acid fast; facultative anaerobe; white to slightly fluorescent on agar; gelatin liquefied; milk curdled and slowly peptonized; no indol; no hydrogen sulphide; ammonia produced; nitrates reduced; no gas; acid from dextrose, levulose, maltose, lactose, glycerin; optimum temperature 25°–28°C.; maximum 40°C.; minimum below 10°C.; thermal death point 55°C.

Synonymy: The author states that this organism resembles closely *B. carotovorus*, *B. omnivorus*, *B. oleraceae* and *B. aroideae.*

Symptoms: The disease is first evident when the leaves wither and gradually turn yellow and the roots and corms become dark brown.

Hosts: *Crocus sativus*, *Allium cepa.*

Geographical distribution: Japan.

Control: The disease is mainly disseminated by infected corms. Selection

of healthy corms and disinfection of seed corms in saturated lime water for half an hour are recommended.

Literature:

1921. Mizusawa, Y. A bacterial rot of the saffron Crocus. Kanag. Agr. Exp. Sta. Bul. 51: 1, 1921.

1923. Mizusawa, Y. A bacterial rot disease of saffrons. Ann. Phytopath. Soc. Japan 1: 1–12, 1923. The disease was first observed in 1909 but was not severe enough to attract special attention until 1917.

Bacillus cypripedii Hori, 1912

Motile by four peritrichiate flagella; 0.5–0.7 x 1.5–2.0μ; no spores; Gram positive; facultative anaerobe; agar colonies white, raised, glistening; gelatin liquefied; milk curdled; gas from glucose; hydrogen sulphide, indol and ammonia produced; diastatic action present.

Synonymy: *Erwinia cypripedii* (Hori) Bergey et al., 1923.

Hori says this may be the same disease described by Peglion as due to *Bacterium oncidii*. But the description given by Peglion is not sufficient to make it possible to decide the question of identity. If they are the same then the name must be changed to *Bacillus oncidii* (Peglion) Hori. Hori says nothing about how his isolations or inoculations were made and it is not certain that he obtained any infections using pure cultures. His only reference to inoculations is as follows: "By repeated infection experiments on different hosts, it became clear that the so-called *brown spot* disease is identical with the *brown rot*, differing merely by symptoms due to difference of texture of the leaf and the host; it is *brown rot* on succulent-leaved orchids and *brown spot* on firm and tough-leaved orchids." Alhough he says nothing about isolations he describes agar plate colonies.

Symptoms: This disease occurs principally on orchids having thick, fleshy, succulent leaves. Signs of the disease are dirty cinnamon or light umber colored spots which spread rapidly over the leaf. The spots soon become deep sunken, orbicular to irregular and deep chestnut brown with a lusterless, more or less wrinkled surface. If the spot starts on the upper surface the lower surface under the spot gradually assumes the same brown color. The rotting also spreads downward into the stem and may destroy the entire stock. On some hosts the color of the spots is yellowish brown and on others a deep, chestnut brown. Brown rot, brown spot.

Hosts: *Aerides japonicum, Cypripedium godefroyae, Cypripedium haynaldium, Cypripedium laevigatum, Cypripedium philippinense, Phalaenopsis amabilis, Phalaenopsis aphrodite, Phalaenopsis schilleriana.*

Geographical distribution: Japan: Formosa, Hondo.

Control: Since the germs enter through wounds caused by careless washing he recommends using a soft sponge soaked in a 1:1,000 solution of corrosive sublimate for wiping the leaf. Excessive watering should be avoided as it favors the disease.

Literature:

1912. Hori, S. A bacterial leaf-disease of tropical orchids. Centralb. f. Bakt. 31: 85–92, 1912.

1923. Bergey's Manual of Determinative Bacteriology, pp. 171–172, 1923.

Bacillus dahliae Hori and Bokura, 1911

Motile by six to eight peritrichiate flagella; 1.0–1.2 x 1.4–1.6μ; no spores; Gram positive; agar colonies round, gray-white; gas from dextrose, sucrose, levulose, lactose, maltose; milk curdled; gelatin and conjac not liquefied; no indol; nitrates reduced; ammonia and hydrogen sulphide produced; facultative anaerobe; optimum temperature 33°C.; minimum 5°C.; thermal death point 50°C.

Synonymy: (Wolf described a bacterial wilt of dahlia due to *Bacterium solanacearum* E. F. Smith but made no inoculations. Cultural and morphological characters of these two organisms differ in important points.)

Symptoms: This organism causes a wilting and yellowing of leaves and stem similar to the wilting due to *Bact. solanacearum.* The rhizome decays internally and a gray liquid oozes out. On the outside the rhizome becomes pale brown to brown as the disease progresses and finally a lead color and has a very bad odor. At first the crown shows no symptoms but later becomes dark brown. The epidermal tissues of the stem are destroyed and the vascular bundles become evident. The parenchyma of the stem is decayed and softened rapidly and the stem becomes hollow and empty.

Host: *Dahlia* sp.

Geographical distribution: Japan.

Control: The author recommends the following as means of control: Crop rotation; the use of phosphate and potash as fertilizers; careful attention to drainage; treatment of the rhizome with 30 per cent milk of lime prepared from unslaked lime for ten minutes.

Literature:

1911. Hori, S. A study of a wilt disease of dahlia. Imp. Agr. Exp. Sta. Nishigahara No. 38: 45–67, 1911.

1914. Ideta, A. Hand-book of the plant diseases of Japan, pp. 29–30, 1914. (In Japanese.)

1922. Wolf, F. A. Additional hosts for *Bacterium solanacearum.* Phytopathology 12: 98–99, 1922.

Bacillus edgeworthiae Hori and Bokura, 1925

Motile by four to seven peritrichiate flagella; 1.2–1.4 x 1.4–2.0μ; no spores; Gram negative; facultative anaerobe; growth on agar smooth, pale gray becoming straw color and the medium becomes pale green; Edgeworthia agar becomes pale chocolate brown; sugars not fermented; milk coagulated; conjac liquefied; indol and ammonia produced; pale green pigment formed on various media; nitrates reduced; optimum temperature 32°C.; killed when held in water at 60°C. for one minute.

Details of isolations and inoculations are not given.

Symptoms: The leaves turn yellow, wither, fall off and the stalk may be easily pulled out of the ground. In early stages the rootlets may be completely rotted and the main root dark brown. In advanced stages the main root turns blackish brown, rots, the epidermis peels off and the vascular tissue becomes disorganized.

Host: *Edgeworthia chrysantha.*

Geographic distribution: Japan.

Literature:

1891. Honda Kosuke. "Disease of Edgeworthia C. Lind, in Shidznokaken." In Journ. Agric. Soc. No. 13, June, 1891 (from Ideta 1: 32–34, 1925). "This is the first paper concerning the disease in Japan."

1916. Bokura Umenojo. "Mitsumata no Tachigare-sei Saikinbyo." (Bacterial die back disease of Edgeworthia C. Lind.) in "Byochugai Zasshi." Journal Plant Protection (Tokyo) **3**: Nos. 10 and 11, Oct. and Nov., 1916—(from Ideta 1: 32–34, 1925).

1925. Ideta Arata. (Supplement to Handbook of the Plant Diseases in Japan) **1**: 32–34, 1925. (In Japanese.)

Bacillus erivanensis (Kalantarien) Stapp, 1928

Motile by several peritrichiate flagella; 0.5–0.7 x 1.25–2.5μ; no spores; Gram negative; nutrient agar colonies round, whitish becoming yellow, glistening; beef gelatin colonies yellowish white, raised, margins entire, becoming yellow; gelatin slowly liquefied; milk curdled and slowly cleared; intense yellow on potato; indol produced; nitrates not reduced; gas from dextrose, sucrose and mannit; no gas from lactose or glycerin.

Synonymy: *Bacterium erivanense* Kalantarien, 1925.

The flagella are peritrichiate. The author says this organism is closely related to *Bacterium herbicola aureum* Düggeli and to *Phytobacter lycopersicum* Groenewege.

Symptoms: This organism causes wilting of seedlings followed by withering and drooping of the foliage and finally drying and death of leaves and entire plant. Thickening of the stem at the root collar was also observed. The cortex of the root becomes brittle and blackish brown in color and contains numerous bacteria.

Host: *Gossypium* sp.

Geographical distribution: Armenia.

Control: Seed sterilization did not control the disease. Soil infection is thought to be the source of the disease.

Literature:

1925. Kalantarien, P. Zwei neue Bakteriosen der Baumwollstande in Armenien. Centralb. f. Bakt. **65**: 297–301, 1925.

1928. Stapp, C. Schizomycetes (Spaltpilze oder Bakterien). In Sorauer's Handbuch der Pflanzenkrankheiten, 2 (fünfte auflage): 202–203, 1928.

Bacillus (?) farnetianus Pavarino, 1911

No plates having been poured, there is no certainty that he was working with pure cultures. He states that by subepidermal inoculation he reproduced the disease. 15.0 x 0.8–1.0μ; Gram positive; iridescent to grayish on agar; gelatin liquefied.

Synonymy: See *Bacterium cattleyae.*

Symptoms: This organism is said to cause superficial rusty spots which become brown to black, dry, depressed areas on leaves and pseudobulbs.

Hosts: *Oncidium ornithorhynchum, Cattleya crispa.*
Geographical distribution: Pavia, Italy.
Literature:

1911. Pavarino, G. L. Malattie causale da bacteri nelle orchidee. Nota preliminare. Atti R. Accad. Naz. Lincei Rend. Cl. Sci. Fis., Mat. e Nat. **20**: 233–237, 1911.
1918. Pavarino, G. L. Alcune malattie delle orchidee causate da bacteri. Atti R. dell Instituto Botanico Univ. Pavia **15**: 81–86, 1918. (Same paper as 1911.)

Bacillus flavidus Fawcett, 1922

Motile by peritrichiate flagella; no spores; Gram negative; clear yellow on potato and gelatin; no gas; acid from glucose, sucrose, lactose, glycerin; milk curdled; indol produced; nitrates not reduced; no diastatic action; gelatin liquefied.

Symptoms: The disease first appears as small translucent dots, a few millimeters in diameter and covered with watery exudate, on the sheaths of the apical bud. These spots form reddish stains and red streaks also occur on the leaves. Two or three of the more recently formed leaves dry up and the apical shoot can be easily pulled out. The interior leaves and sheaths are rotten and surrounded by a thick bad smelling liquid. When the apical shoot has not yet become infected it sometimes pushes out at the side through the weakened decaying sheaths. This condition is known as "pokkah bong."

Host: *Saccharum officinarum.*

Geographical distribution: Argentine.

Control: Rapidly growing plants are usually immune and the varieties Kavangire and 36POJ are resistant. Methods of cultivation and irrigation have no influence upon the disease.

Literature:

1923. Fawcett, G. L. Enfermedades de la cana de azucar en Tucuman. 1. "El polvillo" o podredumbre del brote terminal. Rev. Indust. y Agric. de Tucuman **13**: 5–15, 1922. Rev. Appl. Mycol. **2**: 338–340, 1923. The author believes this disease to be different from the top rot of Java.

Bacillus (?) gossypina Stedman, 1894

Motile but flagella apparently were not stained; 0.75 x 1.5μ; chains; spores; aerobic; gelatin slightly liquefied in old cultures; fluorescent.

Smith, 1920, says "Stedman ascribed the boll rot to his green fluorescent *Bacillus gossypina* but on insufficient evidence."

Symptoms: This organism is said to cause boll rot of cotton.

Host: *Gossypium* sp.

Geographical distribution: Alabama.

Literature:

1894. Stedman, J. M. A new disease of cotton. Cotton boll rot. Agr. Exp. Sta., Auburn Alabama, Bul. **55**: 12 pp., 1894.
1899. Earle, F. S. Diseases of cotton. Cotton boll rot. Alabama Agr. Exp. Sta. Bul. **107**: 311–313, 1899. "Stedman who studied the

disease thought that he had discovered the cause in a germ that he called *Bacillus gossypina*. His results have not been fully confirmed."

1920. Smith, E. F. An introduction to bacterial diseases of plants, p. 314, 1920.

Bacillus harai Hori and Miyake, 1911

Motile by six to eight peritrichiate flagella; 1.0–1.2 x 1.8–2.0μ; spores; Gram positive; facultative anaerobe; colonies grayish white on solid media, on basket willow extract agar black lacquered; clouds bouillon with pellicle; gelatin liquefied; milk coagulated; sugars not fermented; ammonia and indol produced; no hydrogen sulphide; optimum temperature 33°C.; thermal death point 55°C. (for three minutes).

Symptoms: The disease may begin at the tips of the branches and work downward or it may begin at the leaf scars and spread up and down or surround the entire branch. The spots are at first dark brown and enlarge rapidly. The bark becomes shrunken, dry and wrinkled and black. Later on lesions may fade to a yellowish brown.

Host: *Salix* sp.

Geographical distribution: Japan.

Control: The disease is spread through insect wounds and can be controlled by destroying the insects (*Plagiodera distincta*). Spraying with Bordeaux mixture and cutting and burning of infected branches is also recommended. The use of phosphate and potash as fertilizers increases resistance to the disease.

Literature:

1911. Hori, S. Black death disease of Japanese basket willow. Rpt. Imp. Agr. Exp. Sta. Nishigahara **38**: 69–93, 1911.

1914. Ideta, A. Handbook of the plant diseases of Japan, pp. 27–28, 1914. (In Japanese.)

Bacillus (?) hyacinthi septicus Heinz, 1889

1.0 x 4.0–6.0μ; single; aerobic and probably facultative anaerobic; agar and gelatin colonies bluish white, circular, smooth and glistening; growth on potato a dirty yellow; gelatin not liquefied; a strong odor of decay in old cultures.

Synonymy:

Bacterium hyacinthi septicus (Heinz) Chester, 1897.

Bacillus hyacinthi (Heinz) Migula, 1900.

The organism is actively motile but nothing is said about flagella. Coons (1918) concludes that this organism is *Bacillus carotovorus*.

Symptoms: The first indication of the disease is a delayed development apparent particularly at blossoming time. Blossoms fall off before unfolding, or open in irregular order and fall off soon after. Finally there is a progressive rotting, first attacking the axis of the inflorescence and then the leaves and bulb scales, and producing a viscous bad smelling slime. The bulbs are entirely softened in two or three days and leaves and scape can easily be lifted out of the bulb scales. At first the bacteria enter the intercellular spaces, cell walls are softened and destroyed and protoplasm consumed.

Hosts: *Allium cepa, Hyacinthus orientalis.*

Geographical distribution: Agram, Yugoslavia.

Literature:

1889. Heinz, A. Zur kenntniss der rotzkrankheiten der pflanzen. Centralb. f. Bakt. 5: 535–539, 1889.

1897. Chester, F. D. A preliminary arrangement of the species of the Genus *Bacterium.* 9th Ann. Rept. Delaware Col. Agr. Exp. Sta., 53–145, 1897.

1900. Migula, W. System der Bakterien 2: 874, 1900.

1901. Smith, E. F. Wakker's hyacinth germ, *Pseudomonas hyacinthi* (Wakker). U. S. Dept. Agr., Div. Veg. Phys. and Path. Bul. 26: 20–21, 1901. He describes a rapid soft white rot which he says is probably identical with *Bacillus hyacinthi septicus* Heinz.

1918. Coons, G. H. The soft rot of hyacinth. Michigan Acad. Sci. Rept. 20: 353–354, 1918.

Bacillus ixiae Severini, 1913

Motile by five to twelve peritrichiate flagella; 0.7 x 1.8–2.3μ; chains; no spores; no capsules; Gram negative; facultative anaerobic; gelatin slowly liquefied; gelatin colonies white, opaque, smooth; milk coagulated but not peptonized; small amount of gas produced; no indol; nitrates not reduced; optimum temperature 28°–30°C.; thermal death point 47°C.

Symptoms: This organism causes a browning and dying back of tops of plants followed by a soft rot of the bulbs. The leaves turn yellow at the tips, the yellowing extending along one or both margins. Gray-black spots appear at the bases of the leaves. The aerial part can be easily pulled away from the corm. In severe cases plants break over at the base. Yellow or reddish, sunken spots develop on the corm which finally becomes flaccid, and a yellow brown mass without characteristic odor can be squeezed out. Both old and young corms are attacked. The bacteria enter the intercellular spaces, destroying the middle lamella and forming cavities.

Hosts: *Crocus sativus, Gladiolus colvilli, Hyacinthus romanus, Ixia maculata, Solanum tuberosum.*

Geographical distribution: Italy, Holland.

Control: Only healthy corms should be used from localities free from the disease. They should be stored during the resting period in a dry well ventilated place. Before planting corms should be immersed for fifteen minutes in water heated to 50°–55°C. This kills the bacteria but does not injure the corm.

Literature:

1913. Severini, G. Una bacteriosi dell' *Ixia maculata* e del *Gladiolus colvilli.* Annali di Botanica (Rome) 11: 413–424, 1913.

1913. Severini, G. Intorno alle attività enzimatiche di due bacteri patogeni per le piante. Annali di Botanica (Rome) 11: 441–445, 1913.

Bacillus (?) lactucae Voglino, 1903

Motile; 0.5 x 2.25μ; spores; lettuce juice gelatin colonies at first ivory white after ten days become a light rose color.

Symptoms: The first signs of the disease are a red or red brown discoloration

of the cortical cells of the collar at the surface of the soil. The inner tissues become more transparent. This is followed by wilting, softening of the tissues and in bad cases rotting of the neck and leaves. The stem is soft and breaks easily and the crown is easily lifted out leaving a hollow of soft brown tissue. The root always remains healthy.

Host: *Lactuca sativa.*

Geographical distribution: Turin, Italy.

Control: Plants heavily fertilized with nitrogen are more susceptible than others.

Literature:

1903. Voglino, P. Sulla batteriosi delle lattughe. Ann. R. Accad. d'Agr. d. Torino **46**: 25–33, 1903.

1905. Voglino, P. Patologie vegetale 1905. *Bacillus lactucae* is not mentioned here although Voglino named the organism two years earlier.

Bacillus lathyri Manns and Taubenhaus, 1913

Motile by eight or more peritrichiate flagella; 0.6–0.85 x 0.75–1.5μ; no spores; no capsules; no chains; Gram negative; aerobic; agar colonies rapid growing, yellow, stellate to amoeboid, smooth, slightly raised, glistening; gelatin slowly liquefied; milk curdled and peptonized; litmus reduced; nitrates not reduced; no gas; acid from dextrose, sucrose, lactose, maltose, glycerin; ammonia and indol produced; weak diastatic action; no growth in Cohn's solution; rapid growth in Uschinsky's with pellicle and no fluorescence; optimum temperature 28°–30°C.; thermal death point 48°–50°C.

Synonymy: Howitt and Stone, 1916, concluded that streak disease of tomato in Canada was due to soil conditions. Orton and McKinney, 1916, isolated a yellow organism from tomato but their inoculations were not successful. Paine and Bewley, 1919 and Paine and Lacey, 1923, considered *Bacillus lathyri* as the cause of streak disease of tomato. Stone and Howitt, 1922, reported that winter blight of tomato could be controlled by the application of fertilizers to the soil. Paine and Lacey, 1923, state that *Bacillus lathyri* and *Ps. phaseoli* should be considered as distinct species. Vanterpool, 1925, concluded that streak of tomato in Quebec was a form of mosaic. Dickson, 1925, found that streak of tomato in Quebec was not due to *Bacillus lathyri* but to inoculation with potato and tomato mosaic virus. Berkeley, 1927, came to the conclusion that tomato streak was due to a filterable virus. In the 45th report of the Ohio Experiment Station tomato streak is attributed to a mixture of tomato and tobacco mosaic viruses. No bacteria were found associated with the disease. Apparently the disease on tomato is not of bacterial origin. Riker, 1927, and 1928, reports having isolated a pathogenic yellow organism from broad beans which also attacks sweet pea. His organism differs in some respects from *Bacillus lathyri* and he does not identify it with that organism.

Symptoms: The disease appears on sweet peas at blossoming time as light reddish brown to dark brown spots and streaks along the stems near the ground. As the lesions become older they become almost purplish in color. Stem lesions gradually enlarge and deepen destroying the cambium and parenchyma and finally killing the plants. Lesions may also occur on petioles and leaves, on the

latter as water-soaked spots. On clover the disease occurs as water-soaked spots on leaves, petioles and sheaths, and as blackening of the stems. On broad bean numerous chocolate colored spots cover large areas of the leaves, and broad sunken chocolate streaks with a bronze lustre and one to four or five inches long occur on the stems. Similar colored patches occur on the pods. The disease may start at the base of the plant and work upward or may attack the plant uniformly. Lower leaves fall prematurely leaving the stems with a few unhealthy leaves at the top and a few small spotted pods.

Hosts: *Lathyrus odoratus, Phaseolus vulgaris, Pisum sativum, Soja max, Trifolium pratense, Vicia faba.*

Geographical distribution: Massachusetts, New York, Maine, Pennsylvania, Delaware, England, Ireland.

Control: Spraying to destroy the black fly, soaking seed for ten minutes in weak lysol or formalin and rejecting seed showing an excess of boring by beetles are recommended as control measures.

Literature:

1909. Massee, G. "Streak" disease of sweet peas. Sweet Pea Annual 22, 1909. He says the disease is physiological.

1912. Chittenden, F. J. On some plant diseases new to or little known in Britain. Journ. Royal Hort. Soc. **37**: 541–550, 1912. Chittenden in England made the first attempt at inoculation work during 1908, 1909, 1910. He considered the fungus *Thielavia basicola* to be responsible for the trouble.

1912. Chittenden, F. J. Diseases of sweet peas. The Sweet Pea Annual, pp. 14–24, 1912.

1912. Massee, G. A disease of sweet peas, asters and other plants. (*Thielavia basicola* Topf.) Roy. Bot. Garden Kew, Bul. of Miscl. Information, No. 1: 44–52, 1912. He also attributed the disease to *Thielavia basicola.*

1912. W. Sweet pea disease. Gard. Chron. **51**: 3rd ser. 36, 52–53, 84–85, 1912. *Macrosporium solani* is considered to be the cause.

1913. Manns, T. F., and J. J. Taubenhaus. A bacterial disease of the sweet pea and clovers. Gardener's Chronicle **53**: 215–216, 1913. This infection on legumes was first observed by Taubenhaus in Delaware in 1912.

1913. Manns, T. F. A bacterial disease of sweet pea and clovers. Phytopath. **3**: 74–75, 1913. (Abstract of paper read at Cleveland, meeting Dec. 31, 1912–Jan. 3, 1913.)

1914. Taubenhaus, J. J. The disease of the sweet pea. Delaware Col. Agr. Exp. Sta. Bul. 106: 65–69, 1914.

1915. Manns, T. F. Some new bacterial diseases of legumes and the relationship of the organisms causing the same. Delaware Col. Agr. Exp. Sta. Bul. 108: 3–39, 1915.

1916. Howitt, J. E., and R. E. Stone. A troublesome disease of winter tomatoes. Phytopath. **6**: 162–166, 1916. This is the first report from Canada. Their experiments led them to conclude that the cause of the trouble was in the soil.

1916. Orton, C. R., and W. H. McKinney. Winter blight of the tomato. Ann. Rept. Pennsylvania Agr. Exp. Sta. 1914–15: 235–245, 1916. They isolated a yellow bacterium but inoculations were not successful.

1919. Paine, S. G., and W. F. Bewley. Studies in Bacteriosis IV: "Stripe" disease of tomato. Ann. Appl. Biol. **6**: 183–202, 1919. Also abridged in Journ. Min. Agr. Great Britain **26**: 998–1,000, 1920.

1922. Paine, S. G., and M. S. Macey. Chocolate spot disease or streak disease of broad beans. Journ. Min. Agr. Great Britain **29**: 175–177, 1922.

1922. Paine, S. G., and M. S. Lacey. Studies in Bacteriosis VII. Comparison of the "stripe disease" with the "Grand Rapids disease" of tomato. Ann. Appl. Biol. **9**: 210–212, 1922. A comparison of organisms and cross inoculations show that "The stripe disease and the Grand Rapids disease of tomato are distinct diseases caused by two bacterial parasites, *Bacillus lathyri* and *Aplanobacter michiganense*."

1922. Stone, R. E., and J. E. Howitt. Experiments with winterblight or streak of tomatoes. Phytopath. **12**: 41, 1922.

Weber, A. Tomatsygdomme. Aarb. Gartn. (Alm. Dansk Gartnerfor) **4**: 70 p., 1922. *Bacillus lathyri* is reported observed in Denmark.

1923. Paine, S. G., and M. S. Lacey. Studies in Bacteriosis VIII: Further investigation of the "stripe" disease of tomato. Ann. Appl. Biol. **10**: 89–95, 1923. Cross inoculations show a wide host range.

1923. Paine, S. G., and M. S. Lacey. Studies in Bacteriosis IX: "Streak disease of broad bean." Ann. Appl. Biol. **10**: 194–203, 1923.

1923. Paine, S. G., and M. S. Lacey. Studies in Bacteriosis X: "The use of serum-agglutination in the diagnosis of plant parasites." Ann. Appl. Biol. **10**: 204–209, 1923. *Bacillus lathyri* and *Pseudomonas phaseoli* are to be regarded as distinct species. Although showing distinctive cultural characters they showed evidence of cross agglutination.

1923. Taylor, W. H. Tomato-diseases. Black-stripe and its control. New Zealand Journ. Agr. **26**: 101–103, 1923. Due to *Bacillus lathyri* Manns and Taubenhaus.

1925. Brookes, R. St. John, K. Nain and M. Rhodes. The investigation of phytopathogenic bacteria by serological and biochemical methods. Journ. Path. and Bakt. **28**: 203–209, 1925. See *Bacillus carotovorus*.

1925. Dickson, B. T. Tobacco and tomato mosaic. (2) Streak of tomato in Quebec a 'double-virus' disease. Science **62**: 398, 1925.

1925. Stone, R. E. Winter blight or streak of tomatoes. Phytopath. **15**: 300, 1925. He considered the cause malnutrition.

1925. Vanterpool, T. C. The stripe or streak disease of tomatoes in Quebec. Ann. Rept. Quebec Soc. Prot. Plants **16**: 116–123, 1925.

1926. Vanterpool, T. C. Streak or winter blight of tomato in Quebec.

Phytopath. 16: 311–331, 1926. He obtained a culture of *B. lathyri* from Paine but could not reproduce the disease with it by repeated inoculations on tomato. Nor could they reproduce the disease with a yellow organism apparently identical with *B. lathyri* which they isolated.

1927. Rhind, D. Annual report of the Mycologist, Burma, for the year ending June 30, 1926: 6, 1927. Chocolate leaf spot of broad beans, possibly due to *Bacillus lathyri* is recorded for the first time.

1927. Berkeley, G. H. Studies in tomato streak. Scient. Agric. 7: 210–223, 1927. The author considers that his experiments have clearly demonstrated that the disease is of the filterable virus type.

1927. Forty-fifth report of the Ohio Agricultural Experiment Station for 1925–26. Ohio Agr. Exp. Sta. Bul. 402: 40, 1927.

1927. Riker, A. J. Une maladie bactérienne des feves. Rev. Path. Vég. et Entom. Agr. 14: 199–200, 1927. An organism has been repeatedly isolated from chocolate spot of beans in pure culture and on inoculation reproduced the disease. It also attacks sweet pea.

1928. Riker, A. J. A bacterial disease of broad beans. Phytopath. 18: 136, 1928. (Abstract.) The organism was isolated in England from "chocolate spots" and its pathogenicity proven. A non-pathogenic organism having the same number was found in association.

Bacillus lilii Uyeda 1919

Motile by six to eight peritrichiate flagella; 0.6–0.7 x 0.8–1.0μ; Gram positive; facultative anaerobe; brilliant gray on agar; nitrates reduced; ammonia, hydrogen sulphide and indol produced; gelatin slightly liquefied; milk coagulated; sugars not fermented; killed at 50°C. for three minutes.

Symptoms: Deep brown oval to irregular spots occur on leaves and bulb scales. When the bulbs are attacked the growth of the young plant is greatly retarded. Pale brown stripes on the stem may enlarge and cause damping off. Infected leaves may fall off prematurely.

Hosts: *Lilium auratum*, *Lilium cordifolium*, *Lilium elegans*, *Lilium hansoni*, *Lilium longiflorum*, *Lilium medeoloides*, *Lilium rownii*, *Lilium speciosum*, *Lilium tigrinum*, *Lilium venustum*.

Geographical distribution: Japan.

Control: Rotation of crops, avoidance of infected bulbs, soil disinfection with formalin, spraying with Bordeaux mixture, avoidance of excess of nitrogenous fertilizers are all recommended. *Lilium speciosum* is considered the most resistant variety. *L. tigrinum*, *L. auratum* and *L. venustum* are the most susceptible.

Literature:

1919. Bokura, U. A bacterial disease of the lily. Ann. Phytopath. Soc. Japan 1: 36–90, 1919. Abstract in Bot. Abstr. 4: 1243, 1920.

1925. Ideta, A. Supplement to Handbook of the plant diseases in Japan 1: 34–37 1925. (In Japanese.)

Bacillus mangiferae Doidge, 1915

Motile by two to eight peritrichiate flagella; 0.5–0.7 x 0.8–2.6μ; chains; capsules; no spores; Gram positive; not acid fast; aerobic, facultative anaerobe; beef agar colonies glistening smooth, yellow, slightly raised, center dense surrounded by concentric rings with irregular lobate margin; vigorous growth in bouillon with tough slimy ring and thin pellicle; growth on potato yellowish, glistening; gelatin liquefied; milk slowly coagulated and casein slowly dissolved; slight clouding in Cohn's solution; no growth in Uschinsky's or Fermi's solutions; no gas; slight acid production from lactose, sucrose, glycerin, levulose, dextrose; no diastatic action; nitrates reduced; indol and ammonia produced; hydrogen sulphide not produced; optimum temperature about 30°C.; maximum 45°C.; minimum 5–6°C.; thermal death point 60°C.

Synonymy: *Erwinia mangiferae* (Doidge) Bergey et al., 1923.

Symptoms: The disease is most conspicuous on the fruit but also occurs on stems, leaves, petioles and pedicels. Leaf lesions are at first small, angular water-soaked areas. They do not increase much in size, rarely exceeding 2–3 mm. in diameter but if numerous may coalesce and form larger spots. These soon turn brown, the surface is somewhat raised and shining and there is frequently a slight exudation of gum. On old leaves spots become white and dry and crack out. Infections on the petioles cause longitudinal cracks 1 cm. or less in length. Lesions occur on all parts of the stem but are most common on young rapidly growing tissue. They are common in leaf scars. Stem lesions are discolored and are accompanied by gummosis and formation of deep longitudinal cracks. Frequently by the time the fruit is half grown the whole inflorescence is infected, the fruit stalks become black and dead and the fruit falls. Fruit lesions are at first small, water-soaked areas around white spots indicating the presence of stomata or wounds. These spread irregularly to as much as 15 mm. in diameter become discolored, and cracking takes place and the diseased area becomes much roughened. When infection takes place during rapid growth cracks may extend the entire length of the fruit. Gum exudes from lesions near the point of attachment of the fruit, runs down over the fruit and starts new lesions wherever it touches the surface of the fruit.

Host: *Mangifera indica.*

Geographical distribution: South and East Africa, Egypt.

Control: "Spraying with Bordeaux mixture, iron sulphide or Hycol is useless in checking the disease." The risk of infection can be slightly reduced by gathering and burning all diseased fruits and leaves and by keeping the soil under trees damp with some germicide which will prevent dust carrying the infective bacteria. Peach mango or Figette is the most resistant variety. The most susceptible are Baissac, Maison Rouge, Corde and Dauphine.

Literature:

1914. Evans, I. B. Pole. Report Union Plant Pathologist and Mycologist for the year 1911. Zeitschr. f. Pflanzenkr. 24: 218–219, 1914. He describes briefly a bacterial disease of mango occurring in Transvaal, Natal and Portuguese East Africa.

1915. Doidge, E. M. A bacterial disease of the mango. *Bacillus mangiferae* n. sp. Annals of Applied Biology 2: 1–45, 1915.

1919. Doidge, E. M. The rôle of bacteria in plant diseases. So. African Journ. Sci. **16**: 65–92, 1919.
1923. Bergey's Manual of Determinative Bacteriology, p. 173, 1923.
1925. Briton-Jones, H. R. Mycological work in Egypt during the period 1920–1922. Min. Agric. Egypt, Tech. and Sci. Service Bul. 49 (Bot. Sect.): 129 pp., 1925. *Bacillus mangiferae* is reported on mango.

Bacillus (?) manihotus Arthaud and Berthet, 1912

Gram positive; slow growing; whitish on agar; aerobic.

Synonymy: *Bacillus manihot* Arthaud and Berthet, 1915.

Symptoms: This organism is said to cause an internal rotting of the stems and shoots which wither and die. The bark becomes transparent and through it can be seen dark subcortical lines following the vascular bundles. This rotting of the bundles may be on one side or may be general. Gum pockets are formed from which a yellow gum exudes which reddens on oxidation and forms crusts.

Host: *Manihot esculenta* (*palmata*).

Geographical distribution: Brazil.

Control: Only healthy cuttings, from plantations where the disease has not occurred, should be planted. Cuttings should be cut with care so as not to tear or wound the tissue and should be planted as soon as possible to avoid contamination. Crop rotations with plants not susceptible to the disease should be practiced in fields where the disease has occurred. Resistant varieties should be planted. The dark gray and blue varieties are more resistant than the white and sweet varieties.

Literature:

1912. Bondar, G. Una nova molestia bacteriana das hastes da mandioca. Chacaras e Quintaes **5**: No. 4, 15–18, 1912.
1915. Bondar, G. Molestia bacteriana de mandioca. Bol. Agr. (Sao Paulo) **16**: 513–524, 1915.

Bacillus melonis Giddings, 1910

Motile by four to six peritrichiate flagella; 0.7–0.9 x 1.2–1.6μ; no spores; no capsules; Gram negative; facultative anaerobe; agar colonies rapid growing, round to amoeboid, smooth, slightly convex, glistening, slightly opalescent; gelatin rapidly liquefied; blood serum slowly liquefied; milk coagulated but not cleared; indol, ammonia and hydrogen sulphide produced; nitrates reduced; acid from dextrose, lactose, sucrose, maltose, glycerin; no gas from carbohydrates; gas from milk and potato; potato softened and blackened; strong clouding with ring in Fermi's solution; very strong growth in Uschinsky's with ring and pellicle; no growth in Cohn's; optimum growth about 30°C.; maximum 40°C.; minimum 0°–1°C.; thermal death point 49°–50°C.

Synonymy: *Erwinia melonis* (Giddings) Holland, 1923.

E. F. Smith (1920) considered *Bacillus aroideae* Townsend identical.

Symptoms: Infections are at first evident as water-soaked spots around wounds. These increase rapidly in size, the skin becomes shrunken, the tissue

disintegrates and becomes soft and the melon finally collapses. The organism invades the intercellular spaces and dissolves the middle lamella.

Hosts: (natural) *Cucumis melo;* (artificial) *Beta vulgaris, Brassica rapa, Citrus medica, Cucumis sativus, Daucus carota, Solanum tuberosum.*

Geographical distribution: Vermont, Massachusetts and probably much more widely distributed.

Control: Spraying with Bordeaux mixture or other fungicides; turning the melons or supporting them on blocks or stones to keep them from contact with the soil; and irrigation during dry times to insure uniform continuous growth and to avoid cracking, are recommended. Diseased melons should be immediately removed and destroyed. At least three year crop rotations should be practiced in fields where the disease has been prevalent.

Literature:

1891. Halsted, B. D. Bacteria of the melons. Bot. Gaz. **16**: 303–305, 1891. Reprinted as "Bacterial melon blight" in Ann. Rept. New Jersey Agr. Exp. Sta. for 1891, **12**: 273–276, 1892. Reprinted as "Bacterial melon blight." In Mississippi Agr. and Mech. College Exp. Sta. Bul. 19: 9–11, 1892.

1892. Halsted, B. D. Notes upon bacteria of cucurbits. Proc. Amer. Assoc. Adv. Sci. for 1891, **40**: 315–316, 1892. (Abstract.) See also Bot. Gaz. **16**: 257, 1891. (Abstract.) "The stem decays near the ground and the leaves wilt and 'melt' away." "The same bacteria develop with rapidity in tomato fruits upon the vines and spread through the stems of the inoculated plants."

1892. Sorauer, P. Stenglefäule der Gurken. Zeitschr. f. Pflanzenkr. **2**: 344, 1892.

1905. Clinton, G. P. Bacterial rot of musk melon. Rept. Connecticut Agr. Exp. Sta. 1904, **28**: 320, 1905.

1909. Giddings, N. J. A bacterial rot of the muskmelon. Science **29**: 911, 1909.

1910. Giddings, N. J. A bacterial soft rot of muskmelon caused by *Bacillus melonis* n. sp. Vermont Agr. Exp. Sta. Bul. 148: 366–416, 1910.

1912. Smith, E. F. A new method in bacterial research. Phytopath. **2**: 214–215, 1912.

1920. Smith, E. F. An introduction to bacterial diseases of plants, p. 240, 1920.

1923. Bergey's Manual of Determinative Bacteriology, p. 170, 1923.

Bacillus mesentericus (Flügge) Migula, 1900

Motile by peritrichiate flagella; 0.5 x 1.5–3.0μ; spores; Gram positive; aerobic; gelatin colonies circular, grayish; agar colonies circular to spreading, white to cream-white; milk cleared without coagulation; no indol; nitrates not reduced; acid from dextrose and sucrose; gelatin liquefied; blood serum slightly liquefied; optimum temperature 39°–42°C.; maximum between 49° and 52°C.; minimum 5.5°–8°C.

Synonymy: *Bacillus mesentericus fuscus* Flügge, 1886.

Symptoms: This organism causes a black jelly like rot which may destroy the entire tuber in a week to ten days. The decayed tissues are usually covered with a brown, wrinkled surface growth with a characteristic odor of mice.

Host: *Solanum tuberosum.*

Geographical distribution: Arlington Farm, Rosslyn, Virginia.

Control: Avoid improper storage conditions and heating in transit. Rural New Yorker, Russet Rural and Iris Cobbler were the most susceptible. McCormick and Spaulding Rose were resistant.

Literature:

1886. Flügge, C. Die Mikroorganismen, pp. 321–322, 1886.
1900. Migula, W. System der Bakterien 2: 555–556, 1900.
1908. Swellengrebel, N. H. Sur la nature et les causes de la maladie des taches en couronne chez la pomme de terre. Arch. Neerland. Sci. Exact. et Natur. 13: 151–195, 1908.
1928. Brierley, P. Pathogenicity of *Bacillus mesentericus*, *B. aroideae*, *B. carotovorus*, and *B. phytophthorus* to potato tubers. Phytopath. 18: 819–837, 1928.

Bacillus (?) milletiae Kawakami, 1920

Motile by seven to eight peritrichiate flagella; 0.4–0.6 x 0.9–2.5μ; capsules; no spores; Gram negative; facultative anaerobe; agar colonies round, flat, smooth, waxy yellow, glistening, opaque, margins entire; growth on potato cylinder flat, smooth, glistening, light yellow becoming brown with a metallic lustre; gelatin liquefied; milk cleared without coagulation; nitrates reduced; no gas; acid from sucrose, levulose, glycerin; no diastatic action; thermal death point 50°–53°C.

Symptoms: Irregular hard woody knots 5–10 mm. in diameter occur mostly on old stems.

Host: *Millettia floribunda.*

Geographical distribution: Japan.

Literature:

1920. Kawakami, K., and Y. Suehiko. Bacterial gall on Milletia plant. (*Bacillus milletiae* n. sp.) Bot. Mag. Tokyo 34: 110–115, 1920.

Bacillus nelliae Welles, 1922

Motile by three to seven peritrichiate flagella; 0.37–0.5 x 0.83–2.27μ; white on agar; yellow pigment on potato agar slant; acid and gas from dextrose, lactose, galactose, sucrose, mannit; no acid or gas from glycerin; nitrates not reduced; thermal death point 53°–54°C.

Symptoms: This is a vascular wilt disease of parsley. "The whole behavior of the parasitized plants was precisely like that of solanaceous plants parasitized by *Bacillus solanacearum* E. F. Smith." nep

Host: *Pastinaca sativa.*

Geographical distribution: Philippine Islands.

Literature:

1922. Welles, C. G. Identification of bacteria pathogenic to plants previously reported from the Philippine Islands. Philippine Journ. Sci. 20: 279–284, 1922. (There is no mention of inoculations.)

Bacillus papaveris Ayyar, 1927

Motile by four to eight peritrichiate flagella; 0.35 x 0.5–2.5μ; no spores; no capsules; Gram negative; facultative anaerobe; round, glistening, white-bluish opalescent on agar; growth on potato moderate, spreading, flat, smooth, butyrous, dirty yellowish white becoming grayish yellow; gelatin liquefied; milk curdled but not peptonized; no gas; acid from glucose, lactose; sucrose, glycerol; nitrates reduced; ammonia produced; feeble indol production; feeble diastatic action; optimum temperature 30°C.; thermal death point 56°–60°C.

Synonymy: The author states that this organism differs from *Bacillus aroideae* in being chromogenic.

Symptoms: This organism causes blackening of stem and midribs of leaves in early stages and complete rotting of the plant in the advanced stage. Slimy masses of bacteria exude. Cutting open the stem reveals varying degrees of rot from complete disintegration of the pith to mere discoloration of the vascular ring.

Hosts: *Papaver rhoeas, Argemone mexicana.*

Geographical distribution: Cawnpore and Pusa, India.

Literature

1927. Ayyar, C. S. R. A bacterial soft rot of garden poppy. Mem. Dept. Agr. India, Bact. Ser. 2: 29–33, 1927.

Bacillus phytophthorus Appel, 1902

Motile by peritrichiate flagella; 0.6–0.8 x 1.5–2.5μ; chains; no spores; Gram negative; aerobic and facultative anaerobic; agar colonies rapid growing, circular, grayish-white or slightly bluish-white by transmitted light; gelatin colonies rapid growing, large, circular, opaque white, fringed; gelatin liquefied; white on most media but on Soyka's milk rice it is pale pinkish cinnamon, streaked on raw potato it forms a white slime surrounded by a dark (brown or black) border in the disintegrating flesh of the potato; no indol; hydrogen sulphide produced; nitrates reduced; milk curdled but not cleared; acid from dextrose, sucrose, lactose, galactose, maltose; gas from innosit, lactose and mannit; no gas from potato juice; no growth in Cohn's solution; slight growth in Fermi's; optimum temperature 28°–30°C.; maximum about 36°C.; minimum about 1°C.; thermal death point 47°C.

Synonymy:

Bacillus atrosepticus van Hall, 1902.
Erwinia atroseptica (van Hall) Bergey et al., 1923.
Bacillus melanogenes Pethybridge and Murphy, 1910.
See *Bacillus carotovorus*.
See *Bacillus solanincola*. Organisms to which this disease has been incorrectly attributed by various authors:
Bacillus amylobacter van Tieghem, 1877.
Bacterium navicula Reinke and Berthold, 1879.
Bacillus caulivorus Prillieux and Delacroix, 1890.
Micrococcus phytophthorus Frank, 1898.
Bacillus solaniperda Migula, 1900 (Kramer's bacillus).
Bacillus krameri Chester, 1901 (Kramer's bacillus).

Smith (1910) concluded that *Bacillus solanisaprus* Harrison was very closely related to *Bacillus phytophthorus* Appel but not identical.

Smith (1914) says blackleg was described by Pethybridge and Murphy as due to *B. melanogenes*.

Morse (1917) published results of his comparative studies of *B. atrosepticus* van Hall, *B. solanisaprus* Harrison, *B. melanogenes* Pethybridge and Murphy with the conclusion that they were identical.

Smith (1920) gives his reasons for retaining Appel's name as the causal organism of blackleg rather than van Hall's name. He also says "I have been inclined to think that *Bacillus carotovorus* and *B. phytophthorus* are not strictly identical—but further comparisons are necessary."

Jennison (1923) made a comparative study of *B. solanisaprus* Harrison, *B. atrosepticus* van Hall, *B. melanogenes* Pethybridge and Murphy and *B. phytophthorus* Appel and strains isolated from various parts of the United States. He concluded that they were all the same organism, retained *B. atrosepticus* van Hall as the name of the organism and considered the others synonyms.

Brooks (1925) found that *B. carotovorus*, *B. phytophthorus* and *B. solanisaprus* show a distinct serological relationship as well as identical reactions with sugars, milk and gelatin.

Berridge (1926) states that serological and chemical tests show that *B. carotovorus*, *B. solanisaprus* and *B. phytophthorus* are different organisms although closely related.

Lacey (1926) in cultural, pathological and serological tests found sufficiently marked and constant differences to warrent *B. carotovorus*, *B. phytophthorus* and *B. solanisaprus* being kept as separate species.

Stapp (1928) found that *B. phytophthorus*, *B. atrosepticus* and *B. melanogenes* belonged to one serological group and *B. solanisaprus* and *B. carotovorus* to another. Culturally they are alike and he proposes to include them all in a "*B. phytophthorus* group."

Symptoms: The first signs of the disease in the field are yellowing of the lower leaves and upward curling of upper leaves. The stems and leaves have a tendency to grow upward rather than spread out. At the base of such a plant the stem will be found to be black spotted and more or less softened. The blackening may extend from the seed piece to the surface of the ground or three or four inches above and may show a coating of bacterial slime. Upper parts of the shoot soon wilt, shrivel and fall over. Prior to wilting stems, leaves and flower stalks may show black spots. The organism may enter the tuber from the stem end or through lenticels or wounds causing a uniform softening which progresses very rapidly. The vascular bundles may be discolored or there may be a dark line in the parenchyma at the margin of the diseased area. This black line progresses as the disease advances. Starch is not destroyed, the middle lamella is dissolved and the softened tissue retains its normal color unless exposed to the air when it turns black. The disease progresses most rapidly during warm moist summer weather but may continue on the tubers in storage. Leach (1927) has shown that blackleg is a systemic disease and may be perpetuated by naturally infected tubers, the organism advancing slowly through the vascular bundles, rotting the seed piece and finally attacking the stems of growing plants. Young shoots may be destroyed before appearing above ground. Basal stem rot and tuber rot, blackleg, schwarzbeinigkeit.

Hosts: (natural) *Cucumis sativus, Solanum tuberosum, Symphytum officinale;* (artificial) *Brassica rapa, Daucus carota, Lupinus luteus, Lycopersicum esculentum, Vicia faba.*

Geographical distribution: The disease is widespread in Europe and North America. It occurs in South Africa and probably in all parts of the world where potatoes are grown.

Control: Only certified seed from disease-free plants should be used. Jennison (1923) recommends treatment with corrosive sublimate (0.1 per cent for 1½ hours) or formaldehyde (1:240 for 1½ hours), previous to cutting the tubers. Soaking cut tubers for five minutes in formalin (½ pint to 15 gallons of water) or corrosive sublimate (2 ounces to 15 gallons of water) has been found to give good control. Rose (1925) found soaking for two minutes in 1 pint of formaldehyde to 15 gallons of water at 118°–120°F. superior to soaking in cold solutions. Inspection and roguing of the plot at intervals throughout the season is recommended. Decay of stored tubers may be controlled by storing dry tubers in well ventilated cellars at about 38°F. Long rotations should be practiced in which other susceptible plants do not form a part. Late varieties have been reported as more resistant than early. Irish Cobbler, Green Mountain, Early Ohio, Russet Burbank, Idaho Rural have been reported as susceptible.

Literature:

1878. Hallier, E. Die parasiten der Infektionskrankheiten bei Menschen, Thieren und Pflanzen: I Die Plastiden der niederen Pflanzen, pp. 34–66, 1878, Leipzig. He noted the presence of bacteria in rotting potatoes and reproduced the disease by transferring rotted tissue to sound tubers.

1879. Reinke, J., und G. Berthold. Die Zersetzung der Kartoffel durch Pilze. Untersuch. aus dem Bot. Labor. Univ. Gottingen. **1:** 7–100, 1879. This is the first proof of the bacterial nature of a potato rot.

1888. Sorauer, P. Osterr. Landw. Wochenblatt. 1888. (From Sorauer Handbuch der Pflanzenkrankheiten 2 (5 aufl.): 222, 1928 "Schwarzbeinigkeit" introduced by Sorauer.

1890. Burrill, T. J. Preliminary notes upon the rotting of potatoes. Proc. Ann. Meeting Soc. Prom. Agric. Sci. **11:** 21–22, 1890. This is the first record of the isolation in pure culture of a pathogenic potato bacterium. Burrill isolated bacteria in pure culture from the rotting potatoes and by numerous inoculations proved them to be infectious to potato tubers.

1891. Marneffe, G. de. Journ. de l'Association des anciens elèves de l'Inst. agric. de l'état å Gembloux. **2:** 16–17, 1891.

1892. Burrill, T. J. An additional note on the rot of potatoes. Proc. 12th Ann. Meeting Soc. Prom. Agric. Sci. 1891: 29, 1892. This is a continuation of the record of 1890.

1897. Frank, A. B. Kampfbuch gegen die Schadlinge unserer Feldfruchte, pp. 200–202, 1897. Frank published the first accurate description of the blackleg disease.

1898. Frank, A. B. Untersuchungen über die verschiedenen Erreger der Kartoffelfaule. Ber. d. Deutch. Bot. Ges. **16:** 273–289, 1898.

He was the first investigator to lay special emphasis on the connection between bacterial rot of the tubers and Schwarzbeinigkeit.

1899. Frank, A. B. Die Bakterienkrankheiten der Kartoffeln. Centralb. f. Bakt. 5: 98–102, 134–139, 1899.

1899. Iwanoff, R. S. Über die Kartoffelbakteriosis in der Umgegend St. Petersburgs im Jahre 1898. Zeitschr. f. Pflanzenkr. 9: 129–131, 1899. Jennison (1923) thought this was probably the blackleg disease.

1900. Jensen, H. Versuche über Bakterienkrankheiten bei Kartoffeln. Centralb. f. Bakt. II, 6: 641–648, 1900. He considered bacteria the primary cause of the disease.

1902. Appel, O. Der Erreger der "Schwarzbeinigkeit" bei den Kartoffeln. Berichten der Deutschen Bot. Gesellschaft 20: 128–129, 1902.

1902. Appel, O. Zur Kenntniss der Bakterienfäule der Kartoffeln. Ber. d. Deut. Bot. Ges. 20: 32–35, 1902.

1902. Appel, O. Untersuchungen über das Einmiethen der Kartoffeln. K. Biol. Anst. f. Land-u. Forstwirt. Arb. 2: 373–436, 1902.

1902. Prunet, A. Les maladies bacterienne de la pomme de terre. Revue de Viticulture 17: 379–385, 1902.

1903. Appel, O. Untersuchungen über die Schwarzbeinigkeit und die durch Bakterien hervorgerufene Knollenfäule der Kartoffel. Arb. aus der Biolog. Abt. für Land-und Forst. am Kaiser. Gesundh. 3: 364–432 1903.

1904. Appel, O. Die Schwarzbeinigkeit und die mit ihr zusammenhängende Knollenfäule der Kartoffel. Kaiserl. Gesundheits. Biol. Anst. f. Land-und Forstw. Flugblatt 28: 1–4, 1904.

1905. Appel, O. Neuere Untersuchungen über Kartoffel-und Tomatenerkrankungen. Ver. Angew. Bot., Jahresber. 3: 122–136, 1905.

1905. Jones, L. R. Disease Resistance of Potatoes. U. S. Dept. Agric., B. P. I. Bul. 87: 17–18, 1905. He reports that blackleg was found in Holland, Belgium, Germany, France and England.

1906. Appel, O. Biologie des Einmietens und Einkellerns von Kartoffeln, Rüben und Gemüssen. Lafar's Handb. f. Tech. Mykol. 2: 337–361, 1906. He gives a review of the literature on bacterial rot of potato.

1906. Delacroix, G. Sur une maladie de la pomme de terre produite par *Bacillus phytophthorus* (Frank) O. Appel. Compt. Rend. Acad. Sci. (Paris) 143: 383–384, 1906.

1907. Appel, O., und W. Kreitz. Der derzeitige stand unserer Kenntnisse von den Kartoffelkrankheiten und ihrer Bekampfung. K. Biol. Anst. Land. u. Forstw. 5: 31 pp., 1907.

1907. Johnson, T. Some injurious fungi found in Ireland. Econ. Proc. Roy. Dublin Soc. 1: 345–370, 1907.

1907. Jones, L. R. The black leg disease of the potato. Ann. Rept. Vermont Agric. Exp. Sta. for 1905–1906, 19: 257–265, 1907. He

reports it as occurring in Vermont in 1906. This is the first authentic record of the occurrence of blackleg in the United States (Jennison).

1907. Morse, W. J. Potato diseases in 1907. Maine Agr. Exp. Sta. Bul. 149: 323–329, 1907. He found blackleg in Maine in 1907.

1909. Morse, W. J. Blackleg, a bacterial disease of the Irish potato. Maine Agr. Exp. Sta. Bul. 174: 309–328, 1909.

1910. Hegyi, D. Einige Beobactungen betreffs der Schwarzbeinigkeit der Kartoffel. Ztschr. Pflanzenkrank., **20**: 79–81, 1910.

1910. Hegyi, D. Quelques observations sur le pied noir de la pomme de terre. Compt. Rend. Acad. Sci., Paris **150**: 347–348, 1910. "Sans insectes il n'y avait pas la moindre trace de pied noir."

1910. Pethybridge, G. H. Potato diseases in Ireland. Journ. Dept. Agr. and Techn. Inst. for Ireland, **10**: 251–253, 1910.

1910. Smith, E. F. *Bacillus phytophthorus* Appel. Science (n. s.) **31**: 748–749, 1910. According to Jennison, 1923, Smith was the first American to publish a full account of the blackleg parasite.

1911. Appel, O. Zur Kenntnis der Bakterienfäule der Kartoffel. Mitt. K. Biol. Anst. Land-u. Forstwirtsch. **11**: 12–13, 1911.

1911. Morse, W. J. Control of the blackleg or black-stem disease of the potato. Maine Agr. Exp. Sta. Bul. 194: 201–228, 1911.

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1911. Pethybridge, G. H. Investigations on potato diseases. II Report. Journ. Dept. Agric. and Techn. Inst. for Ireland **11**: 437–440, 1910–11. III Report **12**: 348–351, 1912.

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1920. Smith, E. F. An introduction to Bacterial diseases of plants, p. 253–279, 1920.
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1921. Murphy, P. A. Investigation of potato diseases. Canada Dept. Agr. Bul. 44: 27–32, 1921.
1921. Shapovalov, M., and H. A. Edson. Blackleg potato tuber-rot under irrigation. Journ. Agr. Res. 22: 81–92, 1921.
1923. Bergey's Manual of Determinative Bacteriology, p. 172, 1923.

1923. Jennison, H. M. Potato blackleg with special reference to the etiological agent. Ann. Missouri Bot. Gard. **10**: 1–72, 1923, and Phytopath. **12**: 444, 1922. (Abstract.) Organism should bear name: *Bacillus atrosepticus* van Hall; *B. phytophthorus* Appel, *B. solanisaprus* Harrison and *B. melanogenes* Pethybridge and Murphy are to be considered only as synonyms. For history and literature of blackleg see this paper.

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1925. Chupp, C. Manual of vegetable-garden diseases, pp. 387–388, 1925.

1925. Coons, G. H., and J. E. Kotila. The transmissible lytic principle (Bacteriophage) in relation to plant pathogenes. Phytopath. **15**: 357–370, 1925. "When the lytic principle was spread upon slices from susceptible plants (carrot, potato) infection by *Bacillus carotovorus* and *B. atrocepticus* respectively, was in whole or in part prevented."

1925. Kotila, J. E., and G. H. Coons. Investigations on the blackleg disease of potato. Michigan Agr. Exp. Stat. Techn. Bul. 67: 29 p., 1925.

1925. Leach, J. G. The seed-corn maggot and potato blackleg. Science **61**: 120, 1925. Preliminary experiments indicate that the seed corn maggot (*Phorbia fusciceps*) provides a means of hibernation for the blackleg organism. Seed disinfection will be efficacious only if the seed pieces are planted immediately and are inaccessible to flies.

1925. Rose, R. C. Treating seed potatoes with hot formaldehyde. Minnesota Agr. Ext. Div. Circ. 22: 3 pp., 1925. Hot formaldehyde is considered superior to cold formaldehyde or corrosive sublimate.

1926. Berridge, E. M. Studies on bacteriosis XIV. Chemical agglutination as a means of differentiating bacterial species causing soft rot of potatoes and other vegetables. Ann. Appl. Biol. **13**: 12–18, 1926. Both serological and chemical tests show that *B. phytophthorus*, *B. carotovorus*, and *B. solanisaprus* are identical organisms.

1926. Lacey, Margaret S. Studies in bacteriosis XIII. A soft rot of potato tubers due to *Bacillus carotovorus* and a comparison of the cultural, pathological and serological behavior of various organisms causing soft rots. Ann. of Appl. Biol. **13**: 1–11, 1926. Cultural, pathological and serological tests show a close relationship between *B. carotovorus*, *B. solanisaprus* and *B. phytophthorus*, but differences are sufficiently marked and constant to keep them as separate species.

1926. Leach, J. G. The relation of the seed-corn maggot to potato blackleg. Phytopath. **16**: 68, 1926. (Abstract.)

1926. Leach, J. G. The relation of the seed-corn maggot (*Phorbia fusciceps* Zett) to the spread and development of potato blackleg in Minnesota. Phytopath. **16**: 149–175, 1926.

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1927. Leach, J. G. The nature of seed-piece transmission of potato blackleg. Phytopath. **17**: 155–160, 1927.

1927. Racicot, H. N. Does blackleg overwinter in apparenty healthy potato tubers? Proc. Potato Assoc. America 13: 72–74, 1927. The incidence of blackleg was reduced by about two-thirds by seed treatment with formalin or corrosive sublimate. Blackleg seems to overwinter in apparently healthy tubers produced by diseased plants.

1927. Pape, H. Krankheiten und Schädlinge der Lupine. Illus. Landw. Zeit. **47**: 316, 1927.

1928. Bailey, H. L. Certified seed potato inspection. Fourteenth Bienn. Rept. Vermont Commissioner of Agric, 1926–1928; 76, 1928. Blackleg was widespread in 1927.

1928. Botjes, J. G. O. Zwartbeenigheid van de Aardappelplant. (Blackleg of the potato plant.) Tijdschr. Plantenz. **34**: 91–105, 1928.

1928. Brierley, P. Pathogenicity of *Bacillus mesentericus*, *B. aroideae*, *B. carotovorus*, and *B. phytophthorus* to potato tubers. Phytopath. **18**: 819–837, 1928.

1928. Esmarch, F. Die Schwarzbeinigkeit der Kartoffeln. Die Kranke Pflanze **5**: 108–109, 1928.

1928. Stapp, C. Die Schwarzbeinigkeit und Knollennassfaüle der Kartoffel. Arbeiten aus der Biologischen Reichsanstalt für Land. und Fortswirtschaft. **16**: 643–703, 1928.

1928. Stapp, C. Schizomycetes (Spaltpilze oder Bakterien). In Sorauer's Handbuch der Pflanzenkrankheiten, 2 (fünfte auflage): 222–241, 1928.

1929. Patel, M. K. Viability of certain plant pathogenes in soils. Phytopath. 19: 295–300, 1929.

Bacillus (?) pollacii Pavarino, 1911

1.0 x 8.0–10.0μ; spores; Gram negative; aerobic; greenish on agar; gelatin liquefied.

No plates having been poured there is no certainty that he was working with pure cultures. He states that he reproduced the disease by sub-epidermal inoculation.

Synonymy: See *Bacterium cattleyae.*

Symptoms: This organism is said to cause irregular, elongated, black, depressed spots on leaves.

Host: *Odontoglossum citrosmum.*

Geographical distribution: Pavia, Italy.

Literature:

1911. Pavarino G. L. Malattie causate da bacteri nelle Orchidee. Nota preliminare. Atti R. Accad. Naz. Lincei Rend. Cl. Sci. Fis., Mat. e Nat. 20: 233–237, 1911.

1918. Pavarino, G. L. Alcune malattie delle orchidee causate da bacteri. Atti dell Istituto Botanico R. Univ. Pavia. 15: 81–86, 1918. (Same paper as 1911.)

Bacillus (?) populi Brizi, 1907

Spores; actively motile but flagella not demonstrated; indol produced; milk curdled and peptonized; aerobic; a thick yellow growth on potato; gelatin colonies clouded yellow, and fringed; optimum temperature 24°–26°C.; minimum below 10°C.

Synonymy: Smith (1911) considered *B. populi* one of the yellow saprophytes common on crown galls. *Bact. tumefaciens* produces tumors on poplar.

Symptoms: This organism is said to cause galls or tubercles on the branches of *Populus* sp. On twigs one to two years old tubercles are spherical, smooth to slightly wrinkled and about the size of a pea. As the branch grows the tubercles elongate and surround the branch and become rough and wrinkled and crack open. Tumors may reach a diameter of fifteen centimeters. Frequently large tumors develop into craters or funnel-like depressions with radiating cracks. The tumors may begin at any point on the young twig. Buds do not enter into the formation of the tubercles but may be deformed or killed or develop by the side of the tumor. The tumors begin as slight swellings or elevations of the epidermis which soon falls off and is replaced by a corky covering which quickly assumes a dark hue.

Hosts: *Populus alba, Populus nigra, Populus tremula.*

Geographical distribution: Italy, France.

Literature:

1907. Brizi, U. Ricerche su alcune singolari neoplasie del Pioppo e sul bacterio che le produce. Atti. del Congr. dei Nat. Ital. Prom. della Soc. Ital. di Sci. Nat. Milano 1906: 376–392, 1907.

1911. Smith, E. F., N. A. Brown, and C. O. Townsend. Crown gall: Its cause and remedy. U. S. Dept. Agr., B. P. I. Bul. No. 213: 18, 1911.

Bacillus (?) putrefaciens putridus Delacroix, 1906

0.5–0.7 x 1.2–1.8μ; green in bouillon and gelatin, white to faintly rose on gelatin; gelatin not liquefied. Smith (1914) says "inoculation experiments appear to have been scanty and unsatisfactory." "Artificial inoculations only progressed a few centimeters." Stapp (1928) says it is very doubtful that this is a true bacteriosis.

Synonymy: Delacroix attributes this name to Flügge but Flügge (1886) or (1896) does not name this organism.

Symptoms: This is a soil saprophyte which is said under favorable conditions to destroy the pith of topped tobacco plants.

Host: *Nicotiana tabacum.*

Geographical distribution: France.

Literature:

1886. Flügge, C. Die Mikroorganismen. 1886.
1896. Flügge, C. Die Mikroorganismen. 1896.
1906. Delacroix, G. Recherches sur quelques maladies du tabac en France. Ann. de L'Inst. Nat. Agron. **5**: 154–156, 1906.
1914. Smith, E. F. Bacteria in relation to plant diseases. **3**: 266–267, 1914.
1928. Stapp, C. Schizomycetes (Spaltpilze oder Bakterien). In Sorauer's Handbuch der Pflanzenkrankheiten **2** (fünfte auflage): p. 276, 1928.

Bacillus (?) sacchari Janse, 1891

Spores; aerobic; wrinkled growth on culture media.

Synonymy: Went (1895) says this is probably *Bacillus subtilis.* (For a discussion of the disease and early literature see Smith, 1914.)

Symptoms: This organism is said to cause sereh—a shortening of internodes so that leaves are crowded into a fan-shaped bunch, abnormal stooling, and a red staining of vascular bundles at the nodes.

Host: *Saccharum officinarum.*

Geographical distribution: East Indies.

Literature:

1891. Janse, J. M. Het voorkomen van bacterien in suikerriet. Mededeel. uit's Lands Plantentuin **9**: 1–54, 1891. Also Rev. Bot. Centralb. **49**: 374, **50**: 55, 1892. Zeitschr. f. Pflanzenkr. **3**: 103, 1893.
1891. Janse, J. M. Proeve eener verklaring van Serehverschijnselen. Mededeel. uit's Lands Plantentuin te Buitenzorg, Batavia, Landsdrukkerij **8**: 39 pp., 1891. "Thinks sereh due to plugging of vessels and that pushing of adventive buds is due to the same cause." (Smith, 1914)
1895. Went, F. A. F. C. De serehziekte. Archief. voor de Java Suikerindustrie, p. 589, 1895.

1897. Migula, W. System der Bakterien 1: 312, 1897.

1914. Smith, E. F. Bacteria in relation to plant diseases 3: 72–80, 1914. "Describes *Bacillus sacchari* and *B. glagae*. Work very defective from modern bacteriological standpoint. Janse found his bacilli not only in sugar cane, but in nearly every other plant he examined and in healthy plants as well as diseased. The organisms exist normally in sugar cane and only cause sereh when peculiar unknown conditions arise."

1914. Wolk, P. J. van der. Onderzoekingen over de bacterieziekte, speciaal met het oog op hare beinvloeding door onkruiden, met een. Aanhangsel over de serehziekte te van het suikerriet. Indische Mercuur. 37: 647–650, 1914. He believes that *Bacterium solanacearum* is the cause of sereh disease of sugar cane in Java.

1915. Groenewege, J. De gomziekte van het suikerriet veroorzaakt door *Bacterium vascularum* Cobb. Mededeel. van het Proefstation voor de Java. Suikerindustrie, 5: No. 3, 72, 1915. He states that although he made hundreds of isolations from all parts of sereh-diseased cane he never obtained *Bacterium solanacearum.*

1923. Lee, H. A. Sereh disease of sugar cane in Singapore. Phytopath. 13: 145, 1923.

1923. Lyon, H. L. A simple cure for sereh. The Hawaiian Planter's Record. 27: 352–356, 1923. A review of Wilbrink's paper, 1923. "Miss Wilbrink has now demonstrated that if cuttings from plants having sereh are immersed for half an hour in water maintained at a temperature of from 52° to 55°C., the causative agent of the disease is destroyed and that cuttings so treated will when planted, give rise to healthy canes." She resorted to the hot water treatment of cuttings in an attempt to differentiate between sereh and gumming disease of Java. She found that all cuttings infected with gumming disease were killed outright by the hot water treatment while cuttings infected with sereh might survive but were freed from the disease.

1923. Wilbrink, G. Warmwaterbehandeling van Stekken als Geneesmiddel Tegen de Serehziekte van het Suikerriet. Archief voor de Suikerindustrie in Nederlandsch-Indie. Mededeel. van Het Proefstation voor de Java Suikerindustrie. 31: 1–15, 1923. English abstract. Hawaiian Plant Rec. 27: 352–356, 1923. She discovered that exposure of sereh cane cuttings to hot water for one-half hour at 52°C is sufficient to free them from the disease so that they will yield sound plants. This discovery does away with the idea that the disease can be due to degeneration brought about by continued vegetative propagation or by cultivation in too hot a climate. It makes it very probable that the disease is due to an undiscovered parasite, and makes it possible to have healthy cane for comparison with diseased cane. Mosaic disease of sugar cane does not yield to any such treatment. Wilbrink scouts the idea that there is any causal relation between sereh and the slime disease (*Bacterium solanacearum*) of tobacco and other

plants in Java. This is the most important recent contribution to the study of sereh. For a discussion of the early literature of sereh see Smith, E. F. Bacteria in relation to plant diseases **3**: 72–80, 1914.

1924. Wolzogen Kühr, C. A. H. von. Onderzoekingen aangaande de Mikroflora aanwezig in normaal en serehziek suikerriet. Arch. Suikerindus. Ned.-Indie, **31**: 321–484, 1923. Reviewed in Rev. Appl. Mycol. **3**: 302–303, 1924. *Bacillus herbicola* (*vascularum*).

Bacillus scabiegenus (von Faber) Stapp, 1928

Motile by two to five peritrichiate flagella; 0.85 x 1.7–2.12μ; no spores; facultative anaerobe; cane sugar gelatin colonies pale yellow, round, margins entire; yellowish white, thin, glistening on agar stroke; gelatin apparently not liquefied; gas from cane sugar gelatin; milk not coagulated; optimum temperature 24°C.; maximum about 30°C.; minimum about 8°C.

Synonymy: *Bacterium scabiegenum* von Faber, 1907.

His illustrations of beet scab are very much like those attributed to *Actinomyces* in the United States. He states that he was not able to find any species of *Oospora* on the spots.

Symptoms: The signs of this disease are small black scabs at first like warts and later becoming sunken and corky with raised edges. Pustular scab.

Host: *Beta vulgaris.*

Geographical distribution: Germany, Russia.

Literature:

1907. von Faber, F. C. Über den Pustelschorf der Ruben. Arb. aus Kais. Biol. Anst. f. Land und Forst. **5**: 342–350, 1907. He considered his beet scab as the same disease described on potato by Bolley and claims to have demonstrated that a Schizomycete is the cause of German potato scab.

1927. Appel, O. The diseases of sugar beet. Translated by C. L. Wood, London, 1927. No. 5 Pustule scurf. The appearance is very similar to that of common potato scab. The name *Bacterium scabiegenum* is retained.

1928. Stapp, C. Schizomycetes (Spaltpilze oder Bakterien) in Sorauer's Handbuch der Pflanzenkrankheiten **2**: (fünfte auflage): 103–104, 1928.

1928. Kalashnikoff, K. J. (Outbreak of scab on sugar beet.) La Défense des Plantes, Leningrad **5**: 271–272, 1928. From Rev. Appl. Mycol. **8**: 6, 1929. At Kursk in southwest Russia.

Bacillus serbinowi (Potebnia) n. comb

Motile by peritrichiate flagella; 0.4–0.75 x 1.0μ; no spores; no chains; no capsules; Gram negative; aerobic; growth on agar grayish-white fluorescent; clouds alkaline beef peptone boullion containing cane or grape sugar forming a white flaky precipitate; beef peptone sugar gelatin colonies at first white, round, later turning brown and the margin becoming undulate; gelatin liquefied; gas formed in gelatin and agar media containing sugar; usually no growth on potato but sometimes a slow-growing muddy-white film is formed; no ammonia or hydrogen sulphid produced.

Synonymy:

Bacterium beticola Serbinow, 1913, (*Bacterium beticolum* Smith, Brown, Townsend, 1911 is earlier).

Bacterium serbinowi Potebnia, 1915.

Bacillus beticola (Serbinow) Stapp, 1928.

Symptoms: Buds on diseased roots die and dark spots with longitudinal wrinkles occur on the surfaces of the roots. Kept in the open air such beets wrinkle rapidly, and finally crumble. Sections of the roots show spots in which the tissue has been destroyed and has become a dry putrid mass of a pale chocolate color. Such spots later become cavities. When diseased roots were kept in damp chambers the tissue under the brown wrinkled spots underwent a soft wet rot. Sections of such roots showed diseased spots a centimeter or more in diameter, grayish-brown, gelatinous in consistency, later becoming wet rotted. The fibrovascular bundles were browned but otherwise uninjured. Such roots were rapidly destroyed, a pale yellowish liquid flowing out abundantly and slowly turning dark brown. There is no odor. When the root is entirely destroyed the dead brown parenchyma may be washed off from the uninjured vascular bundles. A brown bacteriosis of the sugar beet.

Host: *Beta vulgaris.*

Geographical distribution: St. Petersburg, Russia (Introduced on roots from Germany).

Control: Only uninjured, disease-free roots should be planted.

Literature:

1913. Serbinow, I. L. Über die neue Bakteriose der Zuckerrubenwurzel. Journ. f. Pflanzenkrankheiten 7: 237–257, 1913. (Russian with German summary.)

1915. Potebnia, A. A. Fungus parasites of the higher plants in Kharkov and adjacent provinces. Kharkov Prov. Agr. Exp. Sta. 1: 1–120, 1915. (In Russian.)

1928. Stapp, C. Schizomycetes (Spaltpilze oder Bakterien). In Sorauer's Handbuch der Pflanzenkrankheiten. 2: (5 aufl.): 93, 1928.

Bacillus (?) solanincola Delacroix, 1901

Motile but flagella not demonstrated; 0.25 x 1.5–1.75μ; no spores; Gram negative; aerobic; colonies pale yellowish white; gelatin not liquefied. It is not certain that he was working with pure cultures.

Synonymy: Delacroix (1901) states that the organism causing the potato disease which he describes seems to him not different from *Bacillus solanacearum* E. F. Smith. Later Delacroix (1901) attributes the disease to *Bacillus solanincola* Delacroix. Delacroix (1906) says the symptoms of the two diseases due to *B. phytophthorus* and *B. solanincola* can not be distinguished. Smith (1914) states that "it is uncertain whether we have to do with *Bacillus phytophthorus*, *Bacterium solanacearum*, or some third organism." Smith was never able to reproduce the disease with a culture of *Bacillus solanincola* received through L. R. Jones from Delacroix. "Either it never possessed any pathogenic properties which is quite probable, or had lost them by cultivation." Smith was unable to find bacteria in any abundance in any of Delacroix's material illustrating his potato disease. This material was examined critically by Smith in 1913. In a

footnote Smith (1914) states that an examination of Delacroix's material showed only evidences of fungus diseases of potato. Jennison (1923) also was unable to produce infections with a culture of *B. solanincola* received from L. R. Jones. Morse (1917) says "it is evident that this disease like that caused by *Bacillus solanacearum*, is a type entirely distinct from blackleg." Stapp (1928) says it is very nearly the accepted opinion that Delacroix's bacterial disease due to *B. solanincola* is really blackleg.

Symptoms: This organism is said to cause livid spots at base of stem with internal browning, brown spots on potato tubers and gum formation.

Hosts: *Lycopersicum esculentum, Solanum tuberosum.*

Geographical distribution: France, Ireland, Germany.

Literature:

1901. Delacroix, G. Rapport sur une maladie bacterienne nouvelle de la pomme de terre. Bul. du Min. de l'Agric. France 20: 1013–1033, 1901.

1901. Delacroix, G. Contribution a l'etude d'une maladie nouvelle de la pomme de terre produite par le *Bacillus solanincola* nov. sp. Compt. Rend. Acad. Sci. (Paris) **133**: 417–419, 1030–1032, 1901.

1906. Delacroix, G. Sur une maladie de la pomme de terre produite par *Bacillus phytophthorus* (Frank). O. Appel. Compt. Rend. Acad. Sci. (Paris) **143**: 383–384. 1906.

1914. Smith, E. F. Bacteria in relation to plant diseases. 3: 214–215, 1914. (And footnote 215.)

1917. Morse, W. J. Studies upon the blackleg disease of the potato, with special reference to the relationship of the causal organisms. Journ. Agr. Res. 8: 80, 1917.

1928. Stapp, C. Schizomycetes (Spaltpilze oder Bakterien). In Sorauer's Handbuch der Pflanzenkrankheiten. *2* (fünfte auflage): 229, 1928.

Bacillus (?) solaniperda Migula, 1900

Motile but flagella not stained; 0.7–0.8 x 2.5–4.0μ; chains; no spores; dirty white on agar; gelatin liquefied; nutrient litmus gelatin first red and then yellow. From his description of the organism it is not possible to identify it with more carefully studied recent isolations. Kramer himself admits that he could obtain no rot unless the tubers were submerged in a culture fluid swarming with bacteria at a temperature of 35°C. When his Bacillus was placed on the cut surface of a living tuber exposed to the air of an ordinary room it was never able to cause the rot.

Synonymy:

Bacillus krameri Chester, 1901.

Bacillus solaniperda Kramer-Migula, 1926.

Kramer (1891) described this organism but did not name it. Migula (1900) and Chester (1901) named the organism from Kramer's description.

Symptoms: This organism is said to cause a soft, wet, yellow rot of the potato tuber. The skin is apparently uninjured but the contents become a soft, bad-smelling pulp usually of a yellowish color. If the skin is punctured a sour fluid escapes which smells of butyric acid. The reaction of the pulp and fluid later become alkaline.

Host: *Solanum tuberosum.*

Geographical distribution: Austria, Japan.

Literature:

1891. Kramer, E. Bakteriologische Untersuchungen über die Nassfäule der Kartoffelknollen. Oesterr. Landwirtsch. Centralb. **1**: 11–26, 1891.

1897. Smith, E. F. The bacterial diseases of plants: A critical review of the present state of our knowledge. Amer. Nat. **31**: 123–138, 1897.

1900. Migula, W. System der Bakterien. **2**: 573–575, 1900.

1901. Chester, F. D. Manual of Determinative Bacteriology, p. 282, 1901.

1926. Ferraris, T. Trattato di Patologia e Terapia Vegetale. 3rd ed. 147–151, 1926.

Bacillus solanisaprus Harrison, 1906

Peritrichiate flagella; 0.6–0.9 x 1.5–4.0μ; no capsules; no spores; Gram negative; facultative anaerobe; gelatin slowly liquefied; agar colonies grayish-white, opalescent in certain lights, glistening, flat; gas from mannit and lactose; no gas from other sugars; milk curdled but not cleared; gas in milk; blood serum not liquefied; acid from glucose, lactose, sucrose, mannit, maltose, levulose, glycerin; indol and hydrogen sulphide produced; nitrates reduced; good growth in Uschinsky's and Fermi's solutions with ring and bluish color; growth on potato slightly raised, spreading, dull, waxy, pale cream becoming dirty white, medium not discolored and very little softened; optimum temperature 25°–28°C.; maximum about 37.5°C.; minimum 0.5°C.; thermal death point 54°C.

Synonymy:

Erwinia solanisapra (Harrison) Holland, 1923.

See *Bacillus phytophthorus* Appel.

See *Bacillus carotovorus.*

Symptoms: The leaves droop and turn yellow, black areas appear on stems and petioles and when cut show brown to black fibrovascular bundles and adjacent tissue. The stem droops and falls to the ground, tubers show discolored, reddish brown areas and the tissue beneath softens, the organism spreading quickly above and below. The bacteria may first appear in the vessels of the fibrovascular bundles and from thence invade the surrounding cells, dissolving the middle lamella, thus causing disintegration of the cells and production of cavities. The flesh softens to a white, watery pulp which finally turns black.

Hosts: (natural) *Solanum tuberosum;* (artificial) *Allium cepa, Apium graveolens, Beta vulgaris, Brassica campestris, Brassica oleracea botrytis, Brassica oleracea capitata, Brassica oleracea caulo-rapa, Brassica rapa, Capsicum annuum, Cucumis sativus, Daucus carota, Helianthus tuberosus, Lycopersicum esculentum, Pastinaca sativa, Raphanus sativus, Tragopogon porrifolius.*

Geographical distribution: Canada.

Control: Only healthy tubers of resistant varieties should be planted, and these on well drained land. Where the disease has been prevalent crop rotation should be practiced. Diseased plants and tubers should be burned. Plants should be sprayed with Paris green to keep down insects and with Bordeaux mixture to prevent late and early blight.

Literature:

1906. Harrison, F. C. A bacterial rot of the potato caused by *Bacillus solanisaprus*. Centralbl. f. Bakt. 17: 34–39, 120–128, 166–174, 384–395, 1906
1912. Smith, E. F. A new method in bacterial research. Phytopath. 2: 214–215, 1912.
1916. Jones, D. H. Some bacterial diseases of vegetables found in Ontario. Ontario Dept. Agr. Bul. 240: 8–12, 1916.
1916. Murphy, P. A. The blackleg disease of potatoes caused by *Bacillus solanisaprus*. Dominion Canada, Dept. Agr. Exp. Farm Circ. 11: 5–8, 1916.
1923. Bergey's Manual of Determinative Bacteriology, p. 170–171, 1923.
1925. Brookes, R. St. John, K. Nain and M. Rhodes. The investigation of phytopathogenic bacteria by serological and biochemical methods. Journ. Path. and Bakt. 28: 203–209, 1925. See *Bacillus carotovorus*.
1926. Lacey, M. S. Studies in bacteriosis XIII: A soft rot of potato tubers due to *Bacillus carotovorus* and a comparison of the cultural, pathological and serological behavior of various organisms causing soft rots. Ann. Appl. Biol. 13: 1–12, 1926. Cultural, pathological and serological tests show a close relationship between *B. carotovorus*, *B. solanisaprus* and *B. phytophthorus* but the differences are sufficiently marked and constant to warrant keeping them as separate species.
1926. Berridge, E. M. Studies in bacteriosis XIV: Chemical agglutination as a means of differentiating bacterial species causing soft rot of potatoes and other vegetables. Ann. Appl. Biol. 13: 12–18, 1926. Both serological and chemical tests show that *B. carotovorus*, *B. solanisaprus* and *B. phytophthorus* are not identical organisms.
1928. Pacheco, G. Doenca bacteriana da batata. Arch. Inst. Biol. Defesa Agric. e Animal. 1: 69–82, 1928. (English abstract.) A soft rot of tubers stored in a warehouse at Sao Paulo, Brazil is attributed to *B. solanisaprus*.

Bacillus (?) sorghi Burrill, 1887

Motile; 0.5–1.0 x 1.0–3.0μ; chains; spores; agar colonies white, pearl-like with peculiarly lobed and fimbriated margins; gelatin not liquefied; white, glazed, sometimes wrinkled, pellicle formed on broth; optimum temperature 36°–37°C.; growth on potato pearly white with sometimes slight tinge of yellow or pink, wrinkled, never sticky, when old dirty white.

The etiology of this disease is uncertain. See Elliott, C. and E. F. Smith (1928) for discussion.

Synonymy: *Bacillus sorghi* (Burrill) Chester, 1897.

Symptoms: This organism is said to cause red spots on the leaves and sheaths of sorghum. These blotches spread to the stalk and brush of broom corn. The roots become red and decay and the stalks are easily lifted from the ground. A faint orange discoloration is the first indication of the disease. The color deepens to red or almost black. Lesions first appear on the inner surfaces of sheaths.

Host: *Holcus sorghum.*
Geographical distribution: Illinois, Kansas.
Literature:

1887. Burrill, T. J. Disease germs: Another illustration of the fact that bacteria cause disease. The Microscope **7**: 321–331, 1887. Proc. Amer. Soc. Microscopists 10th Ann. Meeting Aug.–Sept. 1887; 193–206, 1888.
1888. Kellerman, W. A. Preliminary report on sorghum blight. Kansas Agr. Exp. Sta. Bul. **5**: 56–60, 1888.
1889. Kellerman, W. A. and W. T. Swingle. Sorghum blight. First Annual Report of Kansas Experiment Station, State Agricultural College, for 1888: 281–302, 1889.
1889. Kellerman, W. A. and W. T. Swingle. Status of the sorghum blight. Jour. Mycol. **5**: 195–199, 1889. (Reply to criticisms by O. Comes.)
1897. Chester, F. D. A preliminary arrangement of the species of the genus *Bacterium.* Ann. Rept. Delaware Col. Agr. Exp. Sta. **9**: 53–145, 1897.
1928. Elliott, C., and E. F. Smith. A bacterial stripe disease of broom corn and sorghum. Journ. Agr. Res. **38**: 1–22, 1928.

Bacillus (?) tabacivorus Delacroix, 1906

0.4–0.6 x 0.75–1.5μ; no capsules; no spores; no flagella; Gram negative; aerobic; bouillon clouded with slight pellicle; gelatin colonies brilliant metallic iridescent, slightly raised and dirty white in center, slightly irregular in contour; agar colonies duller, flatter; pale yellowish-white on potato; gelatin not liquefied.

The etiology of this disease is doubtful.

See Smith (1914).

See Stapp (1928) (It is very improbable that this is a true bacteriosis).

Symptoms: This organism is said to cause collar rot of tobacco.
Host: *Nicotiana tabacum.*
Geographical distribution: France.
Literature:

1906. Delacroix, G. Recherches sur quelques maladies du tabac en France. Ann. de L'Inst. Nat. Agron. **5**: 152–154, 1906.
1914. Smith, E. F. Bacteria in relation to plant diseases. **3**: 266–267, 1914.
1928. Stapp, C. Schizomycetes (Spaltpilze oder Bakterien). In Sorauer's Handbuch der Pflanzenkrankheiten. **2** (fünfte auflage): 276, 1928.

Bacillus (?) tabificans Delacroix, 1903

1.0 x 1.5μ; no spores; Gram negative; aerobic; white on culture media.

The etiology of this disease is doubtful. The organism is imperfectly described and it is not clear that the author was working with pure cultures. No statement is made as to motility and flagella were not stained.

Symptoms: This organism is said to cause pale green, irregular, translucent spots on the leaves. The first signs of the disease are wilting of the outer and then of the inner leaves and a spotting of the blade with pale and dark green spots as in

mosaic. The pale green spots on the young leaves are almost transparent. Gradually the spots fade as the leaf blade becomes a uniform yellow and finally dries assuming a yellow grey color. The outer leaves dry first. In severely attacked plants the roots cease to grow.

Host: *Beta vulgaris.*

Geographical distribution: France.

Control: Practice a three year crop rotation. Do not put diseased leaves on the compost pile but bury them directly. Sow only four-year-old seed.

Literature:

1898. Prillieux, E. et G. Delacroix. Premieres observations sur la "Jaunisse des Betteraves." Maladie bacterienne. Bul. Seances Société Nationale d'Agriculture 58: 442–444, 1898.

1898. Prillieux, E. et G. Delacroix. La jaunisse maladie bacterienne de la betterave. Compt. Rend. Acad. Sci. (Paris) 127: 338–339, 1898.

1903. Delacroix, G. Sur la jaunisse de la betterave. Compt. Rend. Acad. Sci. (Paris) 137: 871–872, 1903.

1903. Delacroix, G. Sur la jaunisse de la betterave. Sucrerie Indigene et Coloniale No. 22, 61: 678–686, 1903.

1924. Verslag over de werkzaamheden van den Plantenziektenkundigen Dienst in het jaar 1923. Versl. en Meded. Plantenziektenkundigen Dienst te Wageningen, 34: 66 pp., 1924. Beets were attacked by a disease known in Germany as chlorosis and apparently due to *Bacillus tabificans* Del. The disease occurs in Holland, Denmark, Sweden. Outer leaves first show pale green, mosaic-like spots which spread over the entire leaf and finally turn black. Decay sets in and the stem assumes a glazed, shiny appearance. The only hope of control appears to be speedy eradication of infected plants.

Bacillus theae Hori and Bokura, 1915

Motile by five to eight peritrichiate flagella; 0.8–1.0 x 1.4–1.8μ; spores; short chains; Gram negative; facultative anaerobe; gelatin colonies glistening grayish-white becoming dark brown in two days; gelatin liquefied; milk not coagulated; glucose and sucrose not fermented; slight indol production; colonies on potato at first gray-white becoming a dried straw color.

Symptoms: Circular, concentrically marked, brown spots 2–3 mm. in diameter appear on the old leaves. These gradually increase in size until the whole leaf is browned. In clear weather the spots are red-brown, in rainy weather dark brown. Irregular brown spots also appear on the twigs and petioles. The leaves fall, leaving bare branches. Young shoots and leaves are also attacked. The shoots wither, turn red-brown and finally black.

Host: *Thea sinensis.*

Geographical distribution: Japan.

Control: All infected leaves and branches should be removed and burned. Spraying with Bordeaux mixture is recommended in the spring when the buds are opening, after the first picking and a third time in the fall after the last picking. Nitrogen fertilization should be accompanied by a corresponding application of phosphoric acid and potash.

Literature:

1914. Hori, S. A serious disease of the tea bush. Journ. Plant Protection (Tokyo) **1**: 247–252, 1914.

1915. Hori, S. A serious disease of the tea bush. Journal of Plant Protection (Tokyo) **2**: 1–7, 1915.

1923. Petch, T. The diseases of the tea bush. pp. 64–66, 194, 1923.

Bacillus tracheiphilus E. F. Smith, 1895

Motile by four to eight peritrichiate flagella; 0.5–0.7 x 1.2–2.5μ; capsules; no chains; no spores; Gram negative; aerobic and facultative anaerobic; agar colonies internally reticulated, small, circular, smooth, glistening, white, viscid; gelatin not liquefied; no gas; ammonia and hydrogen sulphide produced; acid from sucrose, dextrose, levulose, glycerin; very little diastatic action; no indol; nitrates not reduced; milk neither curdled nor cleared; no growth in Cohn's solution; grows in Uschinsky's and Fermi's solutions; litmus not reduced; optimum temperature 25°–30°C.; maximum 34°–35°C.; minimum about 8°C.; thermal death point 43°C.

Synonymy: *Erwinia tracheiphila* (E. F. Smith) Holland, 1923.

Symptoms: This is a vascular wound disease transmited by insects and characterized by sudden wilting and shriveling of the foliage. Lesions first appear on the leaves as dull green flabby patches which spread rapidly followed by general wilting of the leaves and finally shrivelling and drying of the stems. Bacteria are abundant in the vascular tissue and exude in viscid white drops from the cut ends of bundles. In rather resistant plants such as squashes the foliage may wilt during the day and partially recover at night. Such plants may also show dwarfing and excessive blossoming and branching.

Hosts: (natural) *Cucumis melo, Cucumis sativus, Cucurbita maxima, Curcubita moschata, Cucurbita pepo;* (artificial) *Benincasa cerifera, Citrullus vulgaris, Cucumis anguria, Cucumis odoratissimus, Cucurbita californica, Cucurbita foetidissima, Echinocystis lobata, Sicyos angulatus.*

Geographical distribution: General throughout the United States east of the Rockies, Canada, Europe, South Africa, Japan.

Control: Diseased plants should be removed and burned or buried as soon as they appear in order to remove the sources of infection. Plants should be sprayed with Boredaux mixture (4–4–50) and lead arsenate (4 lbs.) or dusted with nicotine or with gypsum and calcium arsenate (1–20) to control insects.

Literature:

1891. Halsted, B. D. Bacteria of the melons. Bot. Gaz. **16**: 303–305, 1891.

1893. Smith, E. F. Two new and destructive diseases of cucurbits. Bot. Gaz. **18**: 339, 1893. (Abstract.)

1894. Smith, E. F. Two new and destructive diseases of cucurbits. Proc. Amer. Assoc. Adv. Sci. 42nd Meeting 1893: 258–259, 1894.

1895. Smith, E. F. *Bacillus tracheiphilus* sp. nov., die Ursache des verwelkens verschiedener Cucurbitaceen. Centralbl. f. Bakt. **1**: 364–373, 1895.

1897. Selby, A. D. Certain troublesome diseases of tomatoes and cucurbits. Ann. Rept. Columb. Hort. Soc., for 1896, **11**: 113, 1897.

1897. Selby, A. D. Diseases of cucurbits. I. Bacterial blight (*Bacillus tracheiphilus*). Ohio Agr. Exp. Sta. Bul. 73: 233, 1897.
1898. Smith, E. F. Some bacterial diseases of truck crops. Trans. Peninsula Hort. Soc. **11**: 142–147, 1898.
1899. Iwanoff, K. S. Über die Kartoffelbakteriosis in der Umgegend St. Petersburgs im Jahre 1898. Zeitschr. f. Pflanzenkr. **9**: 131, 1899.
1899. Selby, A. D. Further studies of cucumber, melon and tomato diseases, with experiments. Ohio Agr. Exp. Sta. Bul. 105: 221, 1899.
1899. Sturgis, W. C. Some common diseases of melons. Ann. Rpt. Connecticut Agr. Exp. Sta. for 1898, **22**: 225–235, 1899.
1900. Stone, G. E., and R. E. Smith. The bacterial cucumber wilt. Ann. Rpt. Massachusetts (Hatch) Agr. Exp. Sta. **12**: 57, 1900.
1901. Garman, H. Enemies of cucumbers and related plants. Kentucky Agr. Exp. Sta. Bul. 91: 3–15, 1901.
1901. Smith, E. F. Entgegnung auf Alfred Fischer's "Antwort" in betreff der Existenz von durch Bakterien verursachten Pflanzenkrankheiten. Centralb. f. Bakt. **7**: 190–195, 1901.
1904. Clinton, G. P. Squash wilt. *Bacillus tracheiphilus* Sm. Ann. Rept. Connecticut Agr. Exp. Sta. for 1903, **27**: 359, 1904.
1907. Edwards, S. F. *Bacillus tracheiphilus*. Ann. Rept. Ontario Agr. Coll. Exp. Farm for 1906, **32**: 137, 1907.
1907. Kirk, Bacterial wilt (*Bacillus tracheiphilus*). Ann. Rept. New Zealand Dept. Agr. **15**: 158, 1907.
1909. Sackett, W. G. Wilt of the cucumber, cantaloupe and squash. Colorado Agr. Exp. Sta. Bul. 138: 22–23, 1909.
1909. Troop, J., and C. G. Woodbury. Melon wilt. Ann. Rept. Indiana Agr. Exp. Sta. for year ending June 30, 1908, **21**: 30–31, 1909.
1910. Selby, A. D. A brief handbook of the diseases of cultivated plants in Ohio. Ohio Agr. Exp. Sta. Bul. 214: 394, 1910.
1911. Smith, E. F. Bacteria in relation to plant diseases **2**: 209–299, 1911.
1914. Ideta, A. Handbook of the plant diseases of Japan, pp. 486–488, 1914. (In Japanese.)
1915. Rand, F. V. Dissemination of bacterial wilt of cucurbits. Journ. Agr. Res. **5**: 257–260, 1915.
1915. Smith, E. F. A conspectus of bacterial diseases of plants. Ann. Missouri Bot. Gard. **2**: 390, 1915.
1916. Gilbert, W. W. Cucumber diseases in the middle west. Phytopath. **6**: 104–105, 1916. (Abstract.)
1916. Jones, D. H. Some bacterial diseases of vegetables found in Ontario. Ontario Dept. Agr. Bul. 240: 22–23, 1916.
1916. Rand, F. V., and E. M. A. Enlows. Transmission and control of bacterial wilt of cucurbits. Journ. Agr. Res. **6**: 417–434, 1916.
1920. Rand, F. V., and L. C. Cash. Some insect relations of *Bacillus tracheiphilus*, Erw. Sm. Phytopath. **10**: 133–140, 1920.
1920. Rand, F. V., and E. M. A. Enlows: Bacterial wilt of cucurbits. U. S. Dept. Agr., B. P. I. Bul. 828: 1–43, 1920.

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1922. Doolittle, S. P. Comparative susceptibility of European and American varieties of cucumbers to bacterial wilt. Phytopath. 12: 143–146, 1922.
1923. Bergey's Manual of Determinative Bacteriology, pp. 173–174, 1923.
1924. Weber, A. Tomat-og Agurksygdomme. Gart. Tidende, Kopenhagen 40: 292–293, 1924.
1925. Brookes, R. St. John, K. Nain, and M. Rhodes. The investigation of phytopathogenic bacteria by serological and biochemical methods. Journ. Path. and Bakt. 28: 203–209, 1925. See *Bacillus carotovorus*.
1927. Clayton, E. E. Effect of early spray and dust application on later incidence of cucumber wilt and mosaic diseases. Phytopath. 17: 473–481, 1927. The primary agent of dissemination is the striped beetle *Diabrotica vittata* Fab.
1927. Isely, D. The striped cucumber beetle. Arkansas Agr. Exp. Sta. Bul. 216: 1–36, 1927.
1927. Jewett, H. H. The striped cucumber beetle. Kentucky Agr. Exp. Sta. Circ. 37: 19–34, 1927.
1928. Gilbert, W. W. Control of cucumber and cantaloupe diseases in Maryland. Rept. Maryland Agr. Soc. and Maryland Farm Bureau Federation 12 (1927): 401, 1928. It has now been thoroughly established that the causal organism of wilt disease does not live over winter in the soil or in diseased plants but is carried over winter in the bodies of the striped and 12 spotted beetles which are responsible for the spread of the disease.
192?. Gilman, J. C., and D. R. Porter. Observations on plant diseases in Iowa from 1924–1926. Proc. Iowa Acad. Sci. 34 (1927): 103, 192?.
1928. Tehon, L. R. Methods and principles for interpreting the phenology of crop pests. Illinois Dept. Registr. and Educ. Div., Nat. Hist. Survey Bul. 17: 331–339, 1928. The relation of weather conditions to bacterial wilt of melons is illustrated.
1929. Dana, B. F. Diseases of vegetable and field crops (other than cereals) in the United States in 1928. U. S. Dept. Agric., B. P. I., Plant Disease Reporter, Supplement 68: 78, 1929. A wilt disease of squash causing 56.2 per cent infection is reported from Utah. It may be different from the wilt due to *B. tracheiphilus*.

Bacillus tracheiphilus f. cucumis E. F. Smith 1920

Smith (1920) states that squash is immune to this form of *B. tracheiphilus*. According to Rand and Enlows (1920), who experimented with more than a hundred isolations from various hosts, there are all gradations between isolations highly virulent to cucumber and capable of infecting squash to a greater or

less degree and the isolations weakly virulent to cucumber which invariably give no infection in squash.

See *Bacillus tracheiphilus.*

Literature:

Smith, E. F. An Introduction to Bacterial Diseases of Plants, p. 135, 1920.

Rand, F. V., and E. M. A. Enlows. Bacterial Wilt of Cucurbits. U. S. Dept. Agric., B. P. I. Bul. 828: 1–43, 1920. (Professional Paper.)

Bacillus trifolii Voglino, 1896

Motile; 0.2–0.5 x 1.0–2.5μ; spores; white on gelatin and clover extract.

Symptoms: On the petioles the first signs of disease are very tiny grooves which slowly change into black spots 2–5 mm. long—intensely black areas within a yellowish border. On the under surface of the leaf blade tiny sunken areas first appear and these change into black spots 0.5–2 mm. In advanced stages the spots are also visible on the upper surface surrounded by a yellow border. On the stipules the black spots are irregular in shape. Blackish spots on the calyx occur near the veins.

Hosts: *Trifolium pratense, Trifolium repens, Trifolium resupinatum.*

Geographical distribution: Italy.

Literature:

1896. Voglino, P. Ricerche interno ad una malattia bacterica dei trifogli. Annali della R. Accad. d'Agric. di Torino **39**: 85–95, 1896.

1916. Jaczewski, A. A. Fungus and bacterial diseases of clover. Tula, 1916 (Translation in U. S. D. A. Library). The only bacterial disease mentioned is that due to *Bacillus trifolii* Voglino.

1923. Jones, L. R., M. M. Williamson, F. A. Wolf, and Lucia McCulloch. Bacterial leafspot of clovers. Journ. Agr. Res. **25**: 471–490, 1923. The authors state (p. 472) that Voglino's disease is distinct from the one dealt with in this paper.

Bacillus (?) tubifex Dale, 1912

Motile; 0.8–1.7 x 2.4–5.0μ; spores; chains; white to dirty white on culture media; aerobic and facultative anaerobic; acid from cane sugar; milk coagulated and peptonized with formation of acid and gas; gelatin slowly liquefied; no diastatic action; optimum temperature 25°–35°C.; thermal death point 45°–50°C.; forms large gas bubbles on potato and cane-sugar peptone gelatin.

Stapp, 1928, states that it is very doubtful that this is a true bacterial disease. The disease occurred in the greenhouse and results of inoculation experiments were largely negative and complicated by attacks of fungi.

Symptoms: This disease is confined to the leaves, which may or may not curl. Yellowing of the leaves is accompanied by the formation of brown patches in the leaf blade and on the veins. The veins turn brown from the margin inward. As the leaves turn yellow they fall. Zoogloeal tubes extend through the leaf tissue.

Hosts: *Solanum tuberosum, Lycopersicum esculentum.*

Geographical distribution: Great Britain.

Literature:

1912. Dale, E. A bacterial disease of potato leaves. Annals of Botany (London) **26**: 133–154, 1912.

1928. Stapp, C. Schizomycetes (Spaltpilze oder Bakterien). In Sorauer's Handbuch der Pflanzenkrankheiten 248, 1928.

Bacillus (?) uvae Flügge, 1896

Motile; 0.25 x 3.0–4.0μ; chains; gelatin liquefied; honey yellow on potato.

Synonymy: This organism was named from the work of Cugini and Macchiati.

Bacterium uvae (Cugini et Macchiati) Chester, 1897.

Bacillus uvae Cugini et Macchiati, 1916.

Bacterium uvae Cugini et Macchiati, 1926.

Symptoms: This organism is said to cause a browning, drying, and falling of flowers and fruits of grape. The grape vines turn brown at the top, wither and dry rapidly. This withering and dying progresses down the stem and partially or entirely destroys the clusters of grapes which turn brown, dry and fall.

Host: *Vitis* sp.

Geographical distribution: Italy.

Literature:

1891. Cugini, G. e Macchiati, L. La bacteriosi dei grappoli della vite. Le Staz. Sperim. Agrar. Ital. 20: 579–582, 1891.

1892. Ludwig, F. Lehrbuch der niederen kryptogamen 97, 1892.

1892. Macchiati, L. La bacterosi dei grappoli della vite. Staz. Sper. Agr. Ital. fasc. 4, 22: 341–355, 1892. He describes cultural characters of the organism but says nothing about inoculation.

1892. Macchiati, L. Infezione dei grappoli della vite (*Vitis vinifera*) col. Bacillo della bacterosi. Staz. Sperim. Agrar. Italiane. fasc. 6, 22: 590–592, 1892. He obtained infection by pure culture inoculation and reisolated the organism.

1894. Macchiati, L. La bacteriosis des grappes de la vigne. Rev. Internat. Vitic. D'Oenolog. 1: 98–109, 1894.

1894. Macchiati, L. La bacteriosis des grappes de la vigne. Rev. Inter. d Vit. et D'Oenol. 1: 129–136, 1894.

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1897. Chester, F. D. A preliminary arrangement of the species of the genus Bacterium. 9th Ann. Rept. Delaware Col. Agr. Exp. Sta., 53–145, 1897.

1916. Delacroix, G., et A. Maublanc. Maladies des plantes cultives. Maladies parasitaires 2: 36, 1916.

1926. Ferraris, T. Trattato di Patologia e Terapie Vegetale. 3rd ed. 140, 1926.

Bacterium albilineans Ashby, 1929

Motile by a single polar flagellum; 0.12–0.32 x 0.35–2.1μ; no spores; chains in some media; Gram negative; colonies on blood serum sucrose potato agar frequently remain punctiform but sometimes reach a size of 2 mm. when they are round, convex, smooth, glistening, translucent, light buff-yellow, with entire margins, usually soft but sometimes slimy and tenacious; litmus milk is blued and reduced and the casein is digested without coagulation; gelatin not liquefied; optimum temperature for growth 25°–30°C.

Symptoms: This is a vascular disease exhibiting two distinct phases, the acute

and the chronic. The two phases are quite different in appearance and either one may occur to the exclusion of the other. More often they grade into each other. In the acute form affected plants suddenly wilt and die. Whole stools may be affected or only one or two stalks. Whole fields may be suddenly attacked or only patches in a field. This phase is most pronounced in the driest weather and may be practically absent in seasons of plentiful rainfall. Positive diagnosis of the disease in this phase can only be made when side shoots and suckers show the narrow white stripes of the chronic phase.

The most prominent external symptom of the chronic phase is the straight, narrow, well defined, whitish streaks often extending the entire length of the leaf blade and sheath. These streaks are plainly visible as soon as the young leaf unfolds and turns green. As the leaves grow older the streaks tend to broaden and lose their sharpness of outline, develop irregular reddening especially in the center of the streak and later the affected leaf tissue withers giving the leaf the scalded appearance from which the name is derived. This withering is most pronounced in dry weather. Another external symptom of the chronic phase is the production of side shoots which also show typical streaks on leaf sheaths and blades. These side shoots usually die after attaining a length of six to eighteen inches. Reddening of the vascular bundles is common especially at the nodes. Java gum disease, Gomziekte.

Host: *Saccharum officinarum.*

Geographical distribution: Australia, Fiji, Java, Philippines, Mauritius, probably in Formosa.

Control: The disease may be controlled by the use of highly resistant varieties. North (1926) lists Mahona, H.Q. 243, 7.R. 96, 8.R. 31 and H.Q. 114 as susceptible and Bodila, Malabar, N.G. 14, Innes 131, D. 1135, H. 109, H.Q. 5, H.Q. 409, Q. 813 as highly resistant. North (1929) found Bodila appeared to act as a tolerant carrier, almost every field being infected but suffering no appreciable crop damage. Where it is desired to cultivate a susceptible variety great precaution is needed to secure healthy plants. Any cane grown within a quarter of a mile of diseased cane or raised from seed cane from an unsafe source should not be used for planting. All diseased crops should be ploughed out after harvesting to get rid of sources of infection. Sterilization of cane knives is recommended either by immersion in boiling water for a few minutes or by the use of antiseptics.

Literature:

1915. Groenewege, J. De gomziekte van het suikerriet veroorzaakt door *Bacterium vascularum* Cobb. Mededeel. van het Proefstation voor de Java—Zuikerindustrie. Arch. Suikerindus. Ned. Indie, 23 pp., 1915. He considered the Java and Australian gum diseases identical.

1917. Groenewege, J. De gomziekte van het suikerriet en hare bestrijding. Mededeel. Proefst. voor de Java Suikerind. Landbank. ser. 1917, no. 6. Archief voor de Suikerindustrie in Ned. Indie., pp. 597–638, 1917.

1920. Wilbrink, G. De gomziekte van het suikerriet, hare oorzaak en hare bestrijding. Archief voor de Suikerindustrie in Ned. Indie. Afl. No. 33, 34: 1399–1525, 1920. She concluded that the Java

cane disease, studied by Groenewege, closely resembled the Australian disease (Cobb's disease). She found bacteria in the gum of diseased vascular bundles but never in abundance. She found no such quantity of bacterial slime as in the Australian disease and bacteria were never found in great abundance in cavities of the parenchyma and did not ooze from the stem when cut. She isolated a yellow organism with pure cultures of which she reproduced the disease repeatedly, but it was not the organism described by Groenewege.

1921. Ashby, S. F. Gumming disease of sugar cane in Java. Agr. News 20: 302–303, 1921. Resumé of Wilbrink's 1920 paper.

1922. Lee, H. A. Observations on previously unreported or noteworthy plant diseases in the Philippines. Philippine Agr. Rev. 14: 432, 1922. He calls an unidentified disease red-vascular disease. The identity was uncertain at the time due to the absence of the yellow ooze reported for gum disease by Cobb and others.

1923. Lee, H. A. Gum diseases of sugar cane in the Philippines. Phytopath. 13: 504, 1923. He reports his Philippine red-vascular disease as identical to the bacterial cane wilt of Java.

1924. Brandes, E. W. Important sugar cane diseases *not present* in the United States. The Reference Book of the Sugar Industry of the World 2: 79–81, 1924. He states that it has been demonstrated recently in Java that there are two distinct types of gumming disease.

1924. North, D. S., and H. A. Lee. Java gum disease of sugar cane identical to leaf scald of Australia. Phytopath. 14: 587, 1924. The writers point out the similarity between the disease of sugar cane known as leaf scald in Australia and the gum disease described by Wilbrink which occurs in both Java and the Philippine Islands. They propose using the descriptive name leaf scald as used in Australia for this disease.

1926. North, D. S. Leaf scald; a bacterial disease of sugar cane. Colonial Sugar Refining Co., (Sidney, N. S. Wales), Agric. Rept. 8 (Technical): 80 pp., 1926. Leaf scald is a vascular disease closely resembling Cobb's disease (*Bacterium vascularum*) but the yellowish color and viscid slime production associated with gumming are absent from leaf scald. The parasites differ in size and cultural characters.

1926. Cottrell-Dormer, W. Notes and observations on the red streak associated with Queensland top rot disease. Queensland Agric. Journ. 25: 406–414, 1926.

1926. Shepherd, E. F. S. Diseases of sugar cane in Mauritius. Dept. Agric. Mauritius, Bul. No. 32: 10, 1926.

1928. Shepherd, E. F. S. Le "leaf-scald." La. Rev. Agric. de l'Ile Maurice 1928: 176–178, 1928. The occurrence of leaf scald on Mauritius definitely established.

1929. Ashby, S. F. Gumming disease of sugar cane. Trop. Agriculture (Trinidad) 6: 135–138, 1929. *Bacterium albilineans* n. sp.

1929. Bell, A. F. A key for the field identification of sugar cane diseases. Queensland, Bureau of Sugar Experiment Stations, Div. of Pathology, Bul. 2: 20–21, 1929.
1929. North, D. S. The bacterial vascular diseases of sugar cane. Facts About Sugar 24: 880–881, 1929.
1929. North, D. S. Leaf scald disease of sugar cane and its control. Australian Sugar Journ. 21: 99–110, 169–183, 1929. The cane varieties are listed according to their relative susceptibility to leaf scald.

Bacterium alboprecipitans (Rosen) n. comb.

Motile by single polar flagellum; ave. 0.6 x 1.8μ; no spores; capsules; aerobe; Gram negative; not acid fast; agar colonies white, round, somewhat raised, smooth, amorphous, sticky, margins entire; nitrates reduced; ammonia produced; indol and hydrogen sulphide not produced; no acid or gas from carbohydrates; strong diastatic action; no growth in Cohn's solution; fair growth in Fermi's and Uschinsky's solutions; minimum temperature about 0°C.; optimum 30–35°C.; maximum about 40°C.; thermal death point 41–43°C.; not sensitive to drying, freezing or sunlight.

Synonymy:

Pseudomonas alboprecipitans Rosen, 1922.

Phytomonas alboprecipitans (Rosen) Bergey et al., 1930.

Symptoms: This is a spot disease causing light brown or dark brown spots and streaks of no definite size or shape mostly on the blades and sheaths of foxtail but the lesions may also occur on any part of the plant above ground. Lesions on other hosts vary from light yellow indefinite areas to greyish-green withered spots. There is often a reddish tinge in oats. The organism gains entrance through stomata and water pores.

Hosts: (natural) *Chaetochloa lutescens;* (artificial) *Avena sativa, Chaetochloa geniculata, Chaetochloa italica, Holcus sorghum, Holcus sorghum sudanensis, Hordeum vulgare, Secale cereale, Triticum aestivum, Zea mays.*

Geographical distribution: Arkansas.

Literature:

1919. Rosen, H. H. A preliminary note on a bacterial disease of foxtail. Science 49: 291, 1919.
1922. Rosen, H. H. A bacterial disease of foxtail (*Chaetochloa lutescens*). Ann. Mo. Bot. Gard. 9: 333–402, 1922. Also reprinted in 1924 as Bul. 193 of Arkansas Agr. Exp. Sta.
1930. Bergey's Manual of Determinative Bacteriology, p. 244, 1930. (3rd ed.).

Bacterium andropogoni E. F. Smith, 1911

Motile by one to several bipolar flagella; 0.4–0.8 x 1.3–2.5μ; capsules; no spores; aerobic; Gram negative; not acid fast; beef agar colonies slow growing, round, smooth, glistening, slightly raised, white, very viscid; gelatin and blood serum not liquefied; in beef bouillon growth is moderate, there is a thin lace-like pellicle, and precipitate is viscid; trace of growth in Cohn's solution; slight growth in Fermi's; good growth in Uschinsky's with heavy pellicle; optimum

temperature between 22° and 30°C.; minimum 5°–6°C.; maximum 37°–38°C.; thermal death point 48°C.; no indol; no hydrogen sulphide; diastatic action moderate; milk cleared without coagulation; litmus milk reduced; nitrates not reduced; no gas; acid from dextrose, xylose, arabinose, galactose, levulose.

Synonymy:

Pseudomonas andropogoni (E. F. Smith) Stapp, 1928.

Phytomonas andropogoni (E. F. Smith) Bergey et al., 1930.

See *Bacillus sorghi* Burrill.

Symptoms: This is a spot disease causing red streaks and blotches on the leaves and sheaths of many varieties of sorghum. Single lesions are only a few millimeters in diameter but may extend as long red streaks between the veins. When lesions coalesce they may cover a large part of a leaf blade. The red coloring is not marginal but is continuous throughout the lesion. Exudate is abundant and dries down to red crusts or scales which are readily washed off by rains. Lesions are similar in form on all varieties but vary in color from a deep reddish brown or purple to a brick red. Lesions on a few varieties show no reddening but are tan to brown. Differences in color are due to host reactions. The organisms enter through the stomata.

Hosts: *Holcus sorghum, Holcus sorghum sudanensis, Zea mays.*

Geographical distribution: This disease occurs through the sorghum growing sections of central and northern United States.

Literature:

1905. Smith, E. F., and F. Hedges. Burrill's bacterial disease of broom corn. Science **21**: 502–503, 1905.

1911. Smith, E. F. Bacteria in relation to plant diseases. **2**: 63–64, 1911.

1924. Elliott, C., and E. F. Smith. A bacterial disease of broom corn and sorghum. Phytopath. **14**: 48, 1924. (Abstract.)

1928. Elliott, C., and E. F. Smith. A bacterial stripe disease of broom corn and sorghum. Journ. Agr. Res. **38**: 1–22, 1928.

1928. Haskell, R. J. Diseases of cereal and forage crops in the United States in 1927. U. S. Dept. Agric., B. P. I., Plant Disease Reporter, Supplement 62: 341, 1928. The disease is reported from Texas and Kansas. In Kansas it was common on Feterita and Kansas orange and hybrids of these varieties.

1928. Stapp, C. Schizomycetes (Spaltpilze oder Bakterien). Sorauer's Handbuch der Pflanzenkrankheiten. **2** (fünfte auflage): 27, 1928.

1930. Bergey's Manual of Determinative Bacteriology, p. 244, 1930. (3rd ed.).

Bacterium angulatum Fromme and Murray, 1919

Motile by three to six polar flagella; 0.5 x 2.0–2.5μ; no spores; no capsules; aerobic; Gram negative; not acid fast; agar colonies round, smooth, convex, glistening, opalescent at first, later dull white with opaque center and clear margin, margin undulate; gelatin liquefied; heavy clouding in beef bouillon and no pellicle; a slight dull yellow pigment formed on potato cylinders; milk cleared slowly without coagulation; no gas; acid from dextrose and sucrose; nitrates not reduced; indol produced; thermal death point 45–51°C.

Synonymy:

Pseudomonas angulata (Fromme and Murray) Stapp, 1928.

Phytomonas angulata (Fromme and Murray) Bergey et al., 1930.

Symptoms: This is a spot disease occurring only on the leaves. The spots are irregularly angular, bounded by veins and from 1 to 8 mm. in diameter. In early stages they are circular to slightly angular and almost black in color. The center becomes tan or reddish brown with a darker thin border and often a suggestion of zonation which is inconspicuous. The center dries, becomes paler to almost white and may drop out leaving irregular holes or only the skeleton of the leaf. Tissue bordering the spots is yellowed diffusing gradually into normal green. Angular leaf spot, black fire.

Host: *Nicotiana tabacum.*

Geographical distribution: General through the tobacco sections of eastern United States; also in Ontario and Quebec, Canada; Rhodesia, S. Africa; Nyasaland; Philippine Islands.

Control: The disease should be eliminated from the seed bed by steam sterilization of the soil, by seed disinfection in a 2–2½ per cent formaldehyde solution for fifteen minutes followed by thorough washing and drying or a 1:1,000 mercuric chloride solution for ten minutes, or by spraying young plants with Bordeaux mixture 4–4–50. Seed treatments tend to retard germination. In the field infected leaves should be removed and destroyed and spread by workers prevented. Rotation of crops is also recommended.

Literature:

1919. Fromme, F. D., and T. J. Murray. Angular leafspot of tobacco, an undescribed bacterial disease. Journ. Agr. Res. **16**: 219–228, 1919.

1920. Fromme, F. D. Wildfire and angular spot. Virginia Agr. Exp. Sta. Ext. Bul. 62: 25–30, 1920. Wildfire has halo. Angular spot is angular and never has halo.

1921. Fromme, F. D. Wildfire and angular spot. Rhodesia Agr. Journ. **18**: 411–414, 1921. Probably introduced on seed from the United States.

1921. Fromme, F. D., and S. A. Wingard. Treatment of tobacco seed and suggested program for control of wildfire and angular spot. Phytopath. **11**: 48–49, 1921. (Abstract.)

1921. Taylor, H. W. Note. The Rhodesia Agric. Journ. **18**: 411, 1921.

1921. Wolf, F. A., and A. C. Foster. Studies on the physiology of some plant pathogenic bacteria. North Carolina Agric. Exp. Sta. Tech. Bul. No. 20: 21–24, 25–43, 1921. IV. Thermal death points of some bacterial plant pathogenes in relation to reaction of the medium. V. The fermentative activity of some plant pathogenic bacteria in relation to hydrogen-ion concentration.

1921. Wolf, F. A., and I. V. Shunk. Tolerance to acids of certain bacterial plant pathogenes. Phytopath. **11**: 244–250, 1921.

1922. Fromme, F. D., and S. A. Wingard. Blackfire or angular leafspot of tobacco. Virginia Agr. Exp. Sta. Tech. Bul. 25: 43 pp., 1922.

1922. Fromme, F. D., and S. A. Wingard. Blackfire and wildfire of tobacco and their control. Virginia Agr. Exp. Sta. Bul. 228: 19 pp., 1922.

1922. Wolf, F. A. Studies on fermentation of rare sugars by plant pathogenic bacteria. Journ. Elisha Mitchell Sci. Soc. 38: 12–13, 1922. *Bacterium tabacum* attacks manitol and galactose. *Bact. angulatum* does not.

1922. Departmental activities. Wildfire and angular spot in tobacco. Journ. Dept. Agric. S. Africa 4: 117, 1922. Schilz found that while the lesions on tobacco resembled wildfire the organism isolated was *Bact. angulatum*. *Bact. tabacum* was not once isolated. This may also be true in Rhodesia where Fromme reported both diseases.

1923. Edgerton, C. W. Blackfire and other tobacco diseases. Louisiana Agr. Exp. Sta. Extens. Circ. 65: 7 pp., 1923.

1923. Valleau, W. D. An important period in the life history of two bacterial organisms causing leaf spots on tobacco. Phytopath. 13: 140–144, 1923. "Soil infection occurs first and leaf infection follows and complete control of the disease may be obtained by applications of toxic materials early enough to prevent multiplication of the organisms in the soil."

1923. Valleau, W. D. The control of angular leafspot and wildfire of tobacco. Kentucky Univ., Coll. Agr. Ext. Div. Circ. 162: 4 pp., 1923.

1923. Wolf, F. A. Studies on the physiology of some plant pathogenic bacteria; VII Pectic fermentation in culture media containing pectin. Phytopath. 13: 381–384, 1923.

1924. Smee, C. Entomology. Mycological and bacterial work. Ann. Rept. Dept. Agric. Nyasaland Protectorate for 1923: 35–36, 1924.

1924. Valleau, W. D. The infection of tobacco plant beds by spitting. Science 59: 337–338, 1924.

1924. Valleau, W. D., and C. Hubbard. Angular leaf-spot and wildfire infection of tobacco plant beds by spitting. Phytopath. 14: 51, 1924. (Abstract.)

1925. Brookes, R. St. John, K. Nain, and M. Rhodes. The investigation of phytopathogenic bacteria by serological and biochemical methods. Journ. Path. and Bakt. 28: 203–209, 1925. See *Bacillus carotovorus*.

1925. Major, T. G. Report on tobacco disease investigations. Rept. Tobacco Div. Dominion Exp. Farms, Canada, 1923: 40, 1925.

1925. Newton, A. C. Formaldehyde treatment for bacterial diseases of tobacco. Rhodesia Agric. Journ. 22: 861–862, 1925. Germination was somewhat retarded but not appreciably injured.

1927. Hopkins, J. C. F. On the nature of bacterial diseases of tobacco. Rhodesia Agr. Journ. 24: 129–134, 1927.

1927. 26th Ann. Rept. of the Bureau of Agriculture, Philippine Islands, for the fiscal year ending Dec. 31, 1926: 60, 1927. *Bacterium angulatum* reported from the Cagayan Valley.

1928. Hopkins, J. C. F. Wildfire and angular spot of tobacco. Rhodesia Agr. Journ. 25: 139–143, 1928.

1928. Stapp, C. Schizomycetes (Spaltpilze oder Bakterien). In Sorauer's Handbuch der Pflanzenkrankheiten. 2 (fünfte auflage): 271–274, 1928.

1928. Fortieth Annual Report of the Kentucky Agricultural Experiment Station for the year 1927 (Pt. 1): 17, 1928. Much of the spotting thought to be due to *Bacterium angulatum* was found to be physiological.

1929. Valleau, W. D. Are blackfire and angular leaf spot of tobacco identical? Phytopath. **19**: 93, 1929.

1930. Bergey's Manual of Determinative Bacteriology, p. 243, 1930. (3rd ed.).

Bacterium antirrhini (Takimoto) n. comb.

Polar flagellate; 0.3–0.4 x 0.8–1.2μ; no chains; capsules; no spores; aerobic; Gram negative; agar colonies round, glistening, at first white, later yellow; gelatin liquefied; milk coagulated and peptonized; litmus milk reduced; nitrates reduced; no gas; optimum temperature 26°–27°C.; maximum 34°C.; thermal death point 51°C.

Synonymy: *Pseudomonas antirrhini* Takimoto, 1920.

Symptoms: This is a spot disease characterized by irregular brown leafspots with gray-white centers and on the stems elongated sunken spots with light brown centers and reddish blue margins.

Host: *Antirrhinum majus.*

Geographical distribution: Japan.

Literature:

1920. Takimoto, S. On the bacterial leaf spot of *Antirrhinum majus* L. Bot. Mag. Tokyo **34**: 253–257, 1920. (In Japanese.) *Ps. conjac* is mentioned as similar to *Ps. antirrhini* Takimoto.

Bacterium aptatum Brown and Jamieson, 1913

Bipolar flagella; 0.6–1.3 x 1.2–3.2μ; no spores; no capsules; aerobic; Gram negative; not acid fast; agar colonies smooth, flat, glistening, margins entire, internal fish scale markings, agar becomes green fluorescent; beef bouillon develops a thin whitish pellicle, thick viscid precipitate, fluorescent to dark amber; milk coagulated; gelatin liquefied; ammonia produced; nitrates not reduced; no diastatic action; thick pellicle in Fermi's solution and medium pea-green; thin pellicle and green fluorescence in Uschinsky's solution; no growth in Cohn's solution; indol produced; optimum temperature 27–38°C.; maximum 34°–35°C.; minimum —1°C.; thermal death point 47.5°–48°C.

Synonymy:

Phytomonas aptata (Brown and Jamieson) Bergey et al., 1923.

Pseudomonas aptata (Brown and Jamieson) Stapp, 1928.

Paine and Branfoot (1924) state that this organism is a strain of *B. pyocyaneus.*

Symptoms: This is a spot disease causing water-soaked, brownish colored spots from 2 to 5 mm. in diameter on nasturtium leaves, and on beet leaves dark brown, often black, irregular spots and streaks 3 mm. to 1½ cm. in diameter on the petioles, midribs and larger veins. Discolorations sometimes extend some distance alone the veins with dry brown tissue on either side, cord-like pro-

tuberances sometimes occur in the centers of spots. In badly diseased petioles the tissue becomes softened as with a soft rot. Infection takes place only through wounds.

Hosts: (natural) *Beta vulgaris, Tropaeolum majus;* (artificial) *Capsicum annum, Lactuca sativa, Phaseolus vulgaris, Solanum melongena.*

Geographical distribution: Virginia, Utah, California, Oregon, Korea.

Literature:

1897. Halsted, B. D. Nasturtium blight. 17th Ann. Rept. New Jersey Agr. Exp. Sta. (1895) 1896: 410, 1897. When the foliage is half normal size water spots of all sizes appear and soon become blotched with brown.

1909. Brown, N. A. A new bacterial disease of the sugar beet leaf. Science (n. s.) **29**: 915, 1909.

1909. Jamieson, C. O. A new bacterial disease of nasturtium. Science (n. s.) **29**: 915–916, 1909.

1913. Brown, N. A., and C. O. Jamieson. A bacterium causing a disease of sugar beet and nasturtium leaves. Journ. Agr. Res. **1**: 189–210, 1913.

1923. Bergey's Manual of Determinative Bacteriology, pp. 184–185, 1923.

1923. Nakata, K., T. Nakajima, and S. Takimoto. Studies on sugar beet diseases and their control. Bul. Agr. Exp. Sta. Chosen **6**: 1–118, 1922. (Abstr. in Japanese Journ. Bot. **1**: 43, 1923.) Bacterial leafspot (*Bacterium aptatum*) is recorded.

1924. Paine, S. G., and J. M. Branfoot. Studies in bacteriosis XI. A bacterial disease of lettuce. Ann. Appl. Biol. **11**: 312–317, 1924. The causal organism is described and said to be the same as *Bact. aptatum.* In a footnote they say: "Since this paper went to press Dr. Mehta and Dr. Berridge have shown (see the following paper, p. 318) that *B. marginale* is identical with *B. pyocyaneus* and there is no doubt that the organism here described is also a strain of this latter organism.

1925. Brookes, R. St. John, K. Nain, and M. Rhodes. The investigation of phytopathogenic bacteria by serological and biochemical methods. Journ. Path. and Bakt. **28**: 203–209, 1925. See *Bacillus carotovorus.*

1928. Hirata, E. The bacterial leaf-spot of sugar-beet. Journ. Agr. Exp. Sta. Gov.-Gen. Korea No. **17**: 33 pp., 1928. (Original not seen.) This reference from Japanese Journ. Bot. **4**: 58, 1929.

1928. Stapp, C. Schizomycetes (Spaltpilze oder bakterien). In Sorauer's Handbuch der Pflanzenkrankheiten. **2** (fünfte auflage): 99–100, 1928.

Bacterium atrofaciens McCulloch, 1920

1–4 polar or bipolar flagella; 0.6 x 1.0–2.7μ; chains; capsules; no spores; aerobic; Gram negative; not acid fast; beef agar colonies round, smooth, glistening, white becoming greenish, irregularly concentric internal markings; gelatin liquefied; beef bouillon moderately clouded, yellowish green, rims, sometimes a delicate pellicle; blood serum not liquefied; growth on potato cylinders dull

yellowish white changing to dirty, greenish brown; diastatic action moderate; milk cleared without coagulation, color greenish yellow becoming light brown; litmus milk becomes dark blue and is not reduced; growth in Uschinsky's solution moderate to heavy, the medium becoming pale apple green; abundant growth in Fermi's with thick pellicle and pale bluish green color; no growth in Cohn's; no gas; acid from sucrose, dextrose, galactose; nitrates not reduced; hydrogen sulphide and indol produced; ammonia production feeble; optimum temperature 25–28°C.; maximum 36–37°C.; minimum below 2°C.; thermal death point 48°–49°C.

Synonymy:

Phytomonas atrofaciens (McCulloch) Bergey et al., 1923.

Pseudomonas atrofaciens (McCulloch) Stapp, 1928.

Symptoms: This is a spot disease affecting the leaf, head and grain of wheat. The glumes show dull brownish black areas at the base, sometimes extending over nearly the whole surface of the glume. Usually only the lower third is darkened. Often there is no discoloration visible on the exterior but the inner surface is discolored. The base of diseased grain varies in color from a scarcely noticeable brown to charcoal black. Young lesions on inoculated leaves show small, dark water-soaked spots. These enlarge and elongate, turn yellow and finally light brown and the tissues dry.

Host: *Triticum aestivum.*

Geographical distribution: General in west central states, Michigan, New York, Pennsylvania, Canada.

Literature:

1920. McCulloch, L. Basal glume rot of wheat. Journ. Agr. Res. **18**: 543–552, 1920.

1923. Bergey's Manual of Determinative Bacteriology, p. 185, 1923.

1925. Brookes, R. St. John, K. Nain, and M. Rhodes. The investigation of phytopathogenic bacteria by serological and biochemical methods. Journ. Path. and Bakt. **28**: 203–209, 1925. See *Bacillus carotovorus.*

1928. Sanford, G. B. Cereal diseases in Alberta in 1927. Scientific Agric. **8**: 464, 1928. He reports slight infections of *Bacterium atrofaciens.*

1928. Stapp, C. Schizomycetes (Spaltpilze oder Bakterien). In Sorauer's Handbuch der Pflanzenkrankheiten. **2** (fünfte auflage): 17–18, 1928.

Bacterium barkeri (Berridge) n. comb.

Motile by two to five polar flagella; 0.5–0.8 x 2.0–4.0μ; chains; no spores; no capsules; facultative anaerobe; Gram positive; agar colonies white, circular, raised, glistening; bouillon well clouded with slight rim and pellicle; gelatin colonies liquid with smooth edges, round, concave, moist and glistening, semi-transparent, often with small nuclei in the center surrounded by concentric rings and whitish margins; green fluorescence on glucose peptone solution; gelatin rapidly liquefied; milk slowly cleared without curdling; ammonia produced; diastatic action feeble; no acid or gas from starch, levulose, mannit, glycerin, galactose, saccharose, dextrose, lactose; slight indol production; nitrates not reduced; hydrogen sulphide produced; optimum temperature about 18°C.

Synonymy:

Bacillus barkeri Berridge, 1924.

Phytomonas barkeri (Berridge) Bergey et al., 1930.

Symptoms: In young unopened flower buds infection takes place in the sepals. The tips turn gray and then black and the blackening spreads to the whole calyx and down along the flower stalk. The flower bud blackens, shrivels, and may fall or remain attached for some time to the shoot, whole clusters of blossoms may blacken and fall and the spur may die back to the point of attachment with the branch. In fully opened flowers infection first appears as grayish-black spots on the receptacle. They increase in size, coalesce and the whole receptacle becomes blackened. The infection spreads to the ovary—the fruit fails to set properly and falls. Sometimes the young fruit may be the size of a pea or larger before development is checked. The disease may appear first on the stigma and spread until the whole pistil becomes blackened or it may appear first as small blackened areas on the petals. Frequently young leaves show black spots at the tip or along the margin which usually dry and fall out. Sections of infected spurs show brown spots inside and outside the cambium.

Hosts: *Pyrus* sp., *Prunus domestica.*

Geographical distribution: England.

Literature:

1913. Barker, B. T. P. A preliminary note on a bacterial disease of fruit blossom and foliage. Gard. Chron. 53: 287, 1913. A bacterium was proven to be the cause of the disease.

1913. Barker, B. T. P., and O. Grove. A bacterial disease of fruit blossom. Ann. Rept. Agric. and Hort. Res. Sta., Univ. Bristol, 1913: 76–79, 1913.

1914. Barker, B. T. P., and O. Grove. A bacterial disease of fruit blossoms. Ann. Appl. Biol. 1: 85–97, 1914.

1917. Doidge, E. M. A bacterial blight of pear blossoms occurring in South Africa. Ann. Appl. Biol. 4: 50–74, 1917.

1924. Berridge, E. M. The influence of hydrogen-ion concentration on the growth of certain bacterial plant parasites and saprophytes. Ann. Appl. Biol. 11: 73–84, 1924.

1925. Brookes, St. John R., K. Nain, and M. Rhodes. The investigation of phytopathogenic bacteria by serological and biochemical methods. Journ. Path. and Bakt. 28: 203–209, 1925. See *Bacillus carotovorus*.

1930. Bergey's Manual of Determinative Bacteriology, p. 242, 1930. (3rd ed.)

Bacterium beticola Smith, Brown, Townsend, 1911

Motile by one to four bipolar flagella; 0.4–0.8 x 0.6–2.0μ; capsules; no spores; chains; Gram variable; not acid fast; aerobic; beef agar colonies yellow, glistening, round to slightly lobed, smooth or wrinkled, viscid; heavy clouding in beef bouillon with a yellow ring with strings of viscid growth or a yellow pellicle; diastatic action slight; gelatin slowly liquefied; blood serum not liquefied; nitrates reduced; hydrogen sulphide and ammonia produced; no indol; milk coagulated; litmus in milk reduced; no gas; acid from dextrose, sucrose, maltose,

mannit; grows well in Uschinsky's and Fermi's solutions; no growth in Cohn's; optimum temperature 29°C.; maximum 39°C.; minimum 1.5°C.; thermal death point 51°–52°C.

Synonymy:

Bacterium beticolum Smith, Brown, Townsend, 1911.
Bacterium beticola (Smith, Brown, Townsend) Potebnia, 1915.
Phytomonas beticola (Smith, Brown, Townsend) Bergey et al., 1923.
Pseudomonas beticola (Smith, Brown, Townsend) Stapp, 1928.

Symptoms: This organism causes deeply indented nodular growths, which soon disintegrate, on the crown of beet roots. The bacteria are abundant in the tissues and produce brownish areas of softening and central cavities, which usually contain a viscid fluid. The brownish areas extend from surface lesions toward the interior, the brown color becoming lighter toward the center and having a water soaked appearance. A brown mucilagenous substance oozes out of the cut brown surface. Tuberculosis, bacterial pocket disease.

Host: *Beta vulgaris.*

Geographical distribution: Utah, Colorado, Kansas, Virginia, Michigan.

Control: Elimination of too much nitrogen in the soil will control the disease.

Literature:

1911. Smith, E. F., N. A. Brown, and C. O. Townsend. Crowngall of plants: its cause and remedy. U. S. Dept. Agric., B. P. I. Bul. 213: 194–195, 1911.
1912. Smith, E. F. A new method in bacterial research. Phytopath. 2: 214–215, 1912.
1915. Potebnia, A. A. Fungus parasites of the higher plants in Kharkof Province Agr. Exp. Sta. No. 1: 27–29, 1915. (In Russian.)
1923. Bergey's Manual of Determinative Bacteriology, p. 182, 1923.
1925. Brookes, St. John R., K. Nain and M. Rhodes. The investigation of phytopathogenic bacteria by serological and biochemical methods. Journ. Path. and Bakt. 28: 203–209, 1925. See *Bacillus carotovorus.*
1928. Brown, N. A. Bacterial pocket disease of the sugar beet. Journ. Agr. Res. 37: 155–168, 1928.
1928. Stapp, C. Schizomycetes (Spaltpilze oder Bakterien). In Sorauer's Handbuch der Pflanzenkrankheiten. 2 (fünfte auflage): 102–103, 1928.
1929. Elcock, H. A. The anatomy of the overgrowth on sugar beets caused by *Bacterium beticola.* Papers Michigan Acad. Sci. Arts and Letters, 9: 111–115, 1929.
1929. Patel, M. K. Viability of certain plant pathogens in soils. Phytopath. 19: 295–300, 1929.

Bacterium bowlesii (Lewis and Watson) n. comb.

Motile by two to five bipolar flagella; 0.5–0.7 x 1.2–1.6μ; no spores; no capsules; short chains; aerobic; Gram negative; not acid fast; beef agar colonies smooth, moist glistening, yellowish, viscid, margins entire, producing greenish pigment in beef infusion agar; uniform clouding in beef infusion broth, with heavy viscid sediment, small zoogloeal masses at the surface and broth becomes greenish;

gelatin promptly liquefied; on steamed potato a heavy yellow slime covers the surface; milk coagulated and slowly digested; blood serum slowly liquefied; litmus in milk not reduced; acid from glucose, maltose and xylose; no gas; grows in Cohn's, Uschinsky's and Fermi's solutions; ammonia, indol and hydrogen sulphide produced; nitrates reduced; optimum temperature about 27°C.; maximum 35°C.; minimum −1°C.; thermal death point 39°C.

Synonymy: *Phytomonas bowlesii* Lewis and Watson, 1927.

Symptoms: This organism causes water-soaked leaf spots frequently marginal which soon become somewhat irregular, almost black and the surrounding tissue drys and becomes reddish brown. When the petiole is infected the entire leaf droops and withers.

Host: *Bowlesia septentrionalis.*

Geographical distribution: Vicinity of Austin, Texas.

Literature:

1927. Lewis, J. M., and E. Watson. A bacterial disease of Bowlesia. Phytopathology **17:** 507–512, 1927.

Bacterium briosii Pavarino, 1910

He poured plates to obtain pure cultures and made inoculations by sprinkling or spraying the part with a pure culture in broth and by wounding with a sterile knife. He states that he reproduced the disease on all aerial parts of the plant but more easily near the axillary bud and on the fruit. 1–4 polar flagella; capsules; 2.0–4.0 x 0.4–0.6μ; lemon yellow on agar and gelatin; Gram positive; facultative anaerobe; gelatin liquefied; optimum temperature 15°–16°C.; grows best in neutral or slightly alkaline media. The etiology of blossom end rot has not been clearly established (Stapp, 1928). Brooks (1914), Stucky (1911) and others have held that it is a non-parasitic disease. Brown (1926) describes a stem-end and center rot of tomatoes which is in some respects similar to blossom-end rot and which she states may be caused by any one of several bacterial organisms.

Synonymy:

See *Phytobacter lycopersicum.*

See *Bacterium lycopersici.*

See *Bacillus lycopersici.*

Pavarino (1913) states that he obtained a culture of Groenewege's organism (*Phytobacter lycopersicum*) and compared it with his and that it should be considered a synonym. *Bact. briosii* closely resembles *Bact. vesicatorium* in morphological and cultural characters according to Gardner and Kendrick (1921).

Symptoms: This organism is said to cause rotting of fruit from the blossom end, withering of leaves, twisting and curling of buds and young branches and narrow, depressed, brownish cankered areas on the larger branches and stems.

Hosts: (natural) *Lycopersicum esculentum;* (artificial) *Beta vulgaris, Daucus carota.*

Geographical distribution: Italy, Holland, Germany.

Literature:

1910. Pavarino, G. L. Sulla batteriosi del pomodoro (*Bacterium briosii* n. sp.). Atti Ist. Bot. Della R. Univ. di Pavia ser. 2, **12:** 337–344, 1910.

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1913. Pavarino, G. L. Sopra il marciume dei pomodori. Revista di Patologia Veg. **6**: 161–163, 1913.

1914. Brooks, Ch. Blossom-end rot of tomatoes. Phytopath. **4**: 345–371, 1914.

1921. Gardner, M. W., and J. B. Kendrick. Bacterial spot of tomato. Journ. Agr. Res. **21**: 140, 1921. "The bacteriosis of tomato described in 1910 by Pavarino is of considerable interest. While the fruit lesions are very evidently blossom-end rot, stem and foliage lesions are also present. He isolated from both fruit and leaves a yellow organism with which successful wound inoculations were made on fruit, stems and leaves. He named this organism *Bacterium briosii*. In morphology and cultural characters this closely resembles the organism causing bacterial spot except that it has 1 to 4 flagella, the agar colonies have a lobed margin, and its optimum temperature was lower. As has been previously stated, it is necessary to admit that Pavarino may have been working with a combination of blossom-end rot and bacterial spot, but the description is not sufficiently clear-cut to justify the assumption that *Bact. briosii* is identical with the organism causing bacterial spot."

1926. Brown, N. A. A stem-end and center rot of tomato caused by various unrelated organisms. Journ. Agr. Res. **33**: 1009–1024, 1926.

1927. Krankheiten und Beschadigungen der Kulturpflanzen im Jahre 1925. Mitt. Biol. Reichsanst. für Land-und Forstwirtsch., **32**: 158 pp., 1927. From Rev. Appl. Mycol. **7**: 9, 1928. Tomatoes severely attacked in Silesia, Saxon Free State, Brandenburg, with bacterial fruit rot (*Bacterium briosii*).

1928. Stapp, C. Schizomycetes (Spaltpilze oder Bakterien). In Sorauer's Handbuch der Pflanzenkrankheiten **2** (fünfte auflage): 263–265, 1928.

Bacterium campestre (Pammel) E. F. Smith, 1911

Single polar flagellum; 0.7–3.0 x 0.4–0.5μ; chains; capsule; no spores; aerobic; Gram negative; not acid fast; beef agar colonies pale yellow, deepening with age, non-viscid, small circular or slightly irregular, wet-shining; light clouding in beef bouillon and no true pellicle or rim; gelatin and blood serum slowly liquefied; casein precipitated by lab ferment and partially redissolved; litmus milk blued and more or less reduced; methylene blue reduced; forms a copious yellow slime on potato cylinders; usually no growth in Cohn's solution; scanty growth in Fermi's and Uschinsky's solutions; optimum temperature 30–32°C.; maximum 38°–39°C.; minimum about 5°C.; thermal death point about 51°C.; indol, ammonia and hydrogen sulphide formed; diastatic action strong; nitrates not reduced; acid but no gas from dextrose, lactose, sucrose, glycerin, mannit; no acid and no gas from maltose; resistant to drying.

Synonymy:

Bacillus campestris Pammel, 1895.

Pseudomonas campestris (Pammel) E. F. Smith, 1897.

Bacillus campestris rutabaga E. F. Smith, 1911, (Smith (1911) quotes Potter as using this trinomial but Potter (1903) does not use this name).

Phytomonas campestris (Pammel) Bergey et al., 1923.

Symptoms: This is a vascular disease causing dwarfing, yellowing of leaves and blackening of the vascular tissue. Infection takes place chiefly through the water pores of the leaves but may also enter through wounds and leaf traces. The disease first appears on the cotyledons and seedlings may be destroyed in a few weeks. Wilting of one or more lower leaves is the first field symptom. The blackening of leaf veins may form patches of black network surrounded by yellow or brown parenchyma. This tissue has a dry leathery texture. Infected leaves may fall, one after another, leaving darkened leaf scars and tufts of distorted leaves at the top of the stem. One sided infection results in unequal growth and small imperfect heads. Blackening of vascular bundles of larger petioles and stems is only visible in cut sections. From the cut ends bacteria ooze out in yellow masses.

Hosts: *Brassica arvensis, Brassica campestris, Brassica chinensis, Brassica napus, Brassica nigra, Brassica oleracea acephala, Brassica oleracea botrytis, Brassica oleracea capitata, Brassica oleracea caulo-rapa, Brassica pekinensis, Brassica rapa, Matthiola incana, Raphanus sativus.*

Geographical distribution: General throughout Europe and North America, Japan, Philippines, S. Africa, Bermuda, New Zealand.

Control: The use of disease-free seed appears to be the best means of controlling the disease. Infected seed should be treated with mercuric chloride 1:1,000 for thirty minutes or soaked for 25–30 minutes in hot water at 50°C.

The practice of sanitary methods in the field, spraying to destroy worms and insects, careful handling of plants at the time of transplanting, eradication of wild crucifers, and crop rotation are also recommended. For control of stem end and center rot of tomato see *Bact. malvacearum.*

Literature:

1891. Atkinson, G. F. The botanical section of the American Association of Agricultural Colleges and Experiment Stations.—Washington Meeting. Bot. Gaz. **16**: 265, 1891. Garman of Kentucky gave a paper on "A bacterial disease of cabbages" and stated that he had reproduced the disease by inoculating healthy cabbages. The disease was also reported from Virginia and Alabama.

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Bacterium campestre var. armoraciae McCulloch, 1929

A single polar flagellum; 0.7–2.0 x 0.3–0.5μ; chains; no spores; capsules; Gram negative; not acid fast; aerobic; acid but no gas from dextrose, lactose, sucrose, glycerin, maltose, mannit, galactose, levulose; nitrates not reduced; gelatin and blood serum slowly liquefied; milk rapidly cleared without formation of curd; litmus in milk slowly reduced; scant growth in Uschinsky's solution, slightly better in Fermi's and no growth in Cohn's solution; beef agar colonies wax yellow, round, smooth, glistening, translucent, flat, with entire margins; beef broth moderately and evenly clouded, sometimes with thin yellow rims and pellicles; ammonia, indol and hydrogen sulphide produced in small quantities; strong diastatic action; optimum temperature 28°–30°C.; maximum 36°C.; minimum below 2°C.; thermal death point near 51°C.

Synonymy: *Phytomonas campestris* var. *armoraciae* (McCulloch) Bergey et al., 1930.

Symptoms: Lesions first appear as tiny, translucent, pale-green points, visible only by transmitted light. In twelve to twenty-four hours these become small dark green spots which may increase in size up to 4 mm. Lesions become more or less opaque, yellowish white to brown, or even black, with a dark, almost black border and surrounded by a pale green halo. With age centers sometimes drop out. No bacterial ooze has been observed on the lesions. The vascular system of the leaf is not affected.

Hosts: *Brassica oleracea botrytis*, *Brassica oleracea capitata*, *Phaseolus vulgaris*, *Radicula armoracia* (*Armoracia rusticana*).

Geographical distribution: Virginia, District of Columbia, Connecticut, Missouri, Iowa.

Literature:

1929. McCulloch, L. A bacterial leafspot of horse-radish caused by *Bacterium campestre* var. *armoraciae* n. var. Journ. Agr. Res. **38**: 269–285, 1929.

1930. Bergey's Manual of Determinative Bacteriology, p. 241, 1930. (3rd ed.)

Bacterium cannae Bryan, 1921

Motile by one to three bipolar flagella; 0.5–0.7 x 1.0–2.0μ; capsules; no spores; chains; aerobic; Gram negative; not acid fast; beef agar colonies white, slightly convex, round or irregularly scalloped, viscid; gelatin slowly liquefied; diastatic action weak; growth on potato cylinders scanty, spreading, dirty white, glistening becoming pale brown; in beef bouillon a heavy viscid pellicle forms which often falls slowly, center first, forming an inverted cone, which reaches from pellicle to precipitate; milk cleared without coagulation; litmus in milk reduced; no indol; hydrogen sulphide and ammonia produced; grows in Fermi's and Uschinsky's solutions and very feebly or not at all in Cohn's; optimum temperature 35°C.; maximum 40°C.; minimum 5°C.; thermal death point 52°C.

Synonymy:

Phytomonas cannae (Bryan) Bergey et al., 1923.

Pseudomonas cannae (Bryan) Stapp, 1928.

Symptoms: Infection takes place through the stomata, spreading through the parenchyma of young leaf blades, petioles and stalks. Leaf spots are at first water-soaked, later yellow and finally brown, and vary from stomatal infections to ragged, irregular thin grey-brown areas extending several inches along the leaf blade. Separate lesions between the veins give a striped appearance. Shrinking of diseased tissue causes distortion of the leaves. Infection takes place on young leaves still rolled in the bud and may spread to the petiole and kill the young stalk and bud. The buds do not become soft rotted but are black and dry and may bend over or break off. When the shoot is not destroyed, flower clusters may be ruined by infection of young flower buds which blacken and die or by decay of the stem. One sided infection of stalks may cause cracks through the blackened tissue from which a gummy sap exudes. Infection may extend to the tip of the stalk blackening the pedicels and well formed buds. Rootstalks do not become infected.

Host: *Canna indica*.

Geographical distribution: Connecticut, District of Columbia, Indiana, Illinois.

Control: "It is recommended as a preventive measure that root-stalks for planting be selected as far as possible from healthy stock only, that care be observed to avoid crowding and over-watering before setting out, that good ventilation be maintained in the houses, and that specially sensitive varieties be discarded."

Literature:

1921. Bryan, M. K. A bacterial budrot of cannas. Journ. Agr. Res. 21: 143–152, 1921.
1923. Bergey's Manual of Determinative Bacteriology, pp. 188–189, 1923.
1925. Brookes, St. John R., K. Nain, and M. Rhodes. The investigation of phytopathogenic bacteria by serological and biochemical methods. Journ. Path. and Bakt. 28: 203–209, 1925. See *Bacillus carotovorus.*
1928. Stapp, C. Schizomycetes (Spaltpilze oder Bakterien). In Sorauer's Handbuch der Pflanzenkrankheiten. 2: (fünfte auflage): 65–67, 1928.

Bacterium (?) cattleyae Pavarino, 1911

No plates having been poured, there is no certainty that he was working with pure cultures. He states that he reproduced the disease by wound inoculation. 2.4 x 0.4–0.6μ; aerobic; spore forming; Gram negative; whitish on agar; gelatin not liquefied.

Synonymy: Pavarino's four organisms, *Bacillus pollacii, Bacillus farnetianus, Bacterium cattleyae* and *Bacterium krameriani* are all very imperfectly described and with few omissions the descriptions would be interchangeable.

See Stapp (1928).

Symptoms: This organism is said to cause scattered brown spots with rusty excrescences on leaves and pseudobulbs.

Hosts: *Cattleya harrisoniana, Cattleya warneri.*

Geographical distribution: Rome, Italy.

Literature:

1911. Pavarino, G. L. Malattie causate da bacteri nelle Orchidae. Nota preliminare. Atti R. Accad. Naz. Lincei Rend. Cl. Sci. Fis., Mat. e Nat. 20: 233–237, 1911.
1918. Pavarino, G. L. Alcune malattie delle orchidee causate da bacteri. Atti dell Istituto Botanico R. Univ. Pavia. 15: 81–86, 1918. (Same paper as 1911.)
1928. Stapp, C. Schizomycetes (Spaltpilze oder Bakterien) in Sorauer's Handbuch der Pflanzenkrankheiten 2 (fünfte auflage): 69, 1928.

Bacterium celebense (Gaumann) n. comb.

Motile by one polar flagellum; 0.9 x 1.4μ; no spores; Gram negative; beef agar colonies grayish yellow; a thin pellicle on beef bouillon; milk coagulated and slowly cleared; methylene blue reduced; nitrates not reduced; sodium selenite (0.1 per cent) turned brick red in 24–48 hours; diastase formed.

Synonymy: *Pseudomonas celebensis* Gaumann, 1923.

Symptoms: This disease attacks primarily the vascular bundles and does not spread readily in a lateral direction. It causes yellow striping and drooping of leaves, rotting of the rhizome, abnormal stooling, decay of fruit and exuding of reddish slime from cut bundles. Discolored vascular bundles occur principally in the central portion of the stem. Large brownish-yellow watersoaked spots appear in the tissue and emit an acid odor. All parts show a tendency to arrested development. In acute attacks the growth of vigorous plants is completely

arrested and death rapidly ensues. In the chronic type the attack is milder and is apt to succeed epidemics. The fruit pulp may dissolve leaving a cavity with slimy exudate at the base or the pulp may become a red brown mass of dry shriveled tissue.

Host: *Musa sapientum.*

Geographical distribution: Widespread and destructive in Celebes of the Dutch East Indies and in nearby islands.

Control: The organism retains its virulence for at least a year in the soil and longer in decayed roots. It can be transmitted by diseased seedlings from place to place and by the mucilage adhering to pruning knives. Thorough cleaning out of infected plantations and the use of healthy stock for planting are recommended. Artificial fertilizers may prove beneficial.

Literature:

1916. Rijks, A. B. Rapport over een onderzoek naar de pisangsterfte op de Saleiereilanden. Mededeelingen van het Laboratorium voor Plantenziekten. No. 21. Instituut voor Plantenziekten en Cultures. Departement van landbouw, nijverheid en handel. Batavia 16 pp., 1916. (This is the first exact account of this disease.)

1919. Westerdorp, F. W. J. Jaarboek van het Departement van landbouw, nijverheid en handel in nederlandsch-Indië. Weltevreden, pp. 253–262, 1919. (Two figures show the destructive nature of the disease.)

1921. Gaumann, E. Onderzoekingen over de bloedziekte der bananen op Celebes. I. (Investigations of the blood disease of bananas in Celebes. 1.) Mededeelingen van het Instituut voor Plantenziekten. No. 50. Departement van Landbouw. Nijverheiden Handel Batavia, pp. 1–47, 1921. (Preliminary paper.) English summary.

1923. Gaumann, E. Ueber zwei Bananenkrankheiten in Niederländisch Indien. Zeitschr. f. Pflanzenkr. 33: 1–17, 1923.

1924. Gaumann, E. Onderzoekingen over de bloedziekte der bananen op Celebes. 2. (Investigation on the blood disease of banana in Celebes.) Meded. Inst. voor Plantenziekten 59: 45 pp., 1923. (English summary.) Reviewed in Rev. Appl. Mycol. 3: 344–346, 1924.

Bacterium cerasi (Griffin) n. comb.

Motile by one to two polar flagella; 0.5–0.84 x 1.5–2.5μ; no spores; Gram negative; not acid fast; gelatin liquefied; agar greened; milk coagulated and peptonized; scant growth in starch jelly; no gas; acid from dextrose, sucrose, lactose, maltose, glycerin; no ammonia; nitrates not reduced; thermal death point 48°C.

Synonymy:

Pseudomonas cerasus Griffin, 1911.

Phytomonas cerasi (Griffin) Bergey et al., 1930.

Griffin (1911) says his organism resembles *Bacillus spongiosus* very closely. The only differences were that his organism did not produce spongy colonies on agar and gelatin and did produce a green fluorescence on certain media. See *Bacterium syringae.*

Symptoms: This is a disease of young sweet cherries, causing blighting of buds and spurs, formation of cankers on trunks, and branches and exudation of gum. Infection takes place in the fall or winter spreading during the dormant period in the life of the tree, but showing little external evidence of disease. When the tree resumes active growth in the spring the extent of injury becomes evident. Infected buds do not open with the healthy ones or if they unfold soon darken and die. The disease spreads from blighted buds and spurs to twigs and branches. Affected bark fails to grow, dries up and cracks around the edges, forming typical cankers which may girdle and kill the branches in a single season or may enlarge from year to year, finally girdling the trunk or limbs. Gum formation may take place in the spring at diseased points. Leaf infections are rare but may occur as brownish spots or blotches of variable size and forms. These spots dry and fall out.

Hosts: *Amygdalus persica, Prunus armeniaca, Prunus cerasus, Prunus simoni, Prunus avium.*

Geographical distribution: British Columbia, Washington, Oregon, California.

Control: Cutting out all diseased tissue and disinfecting the wounds with Bordeaux paste or formalin solutions eliminates some sources of infection. Tools should be constantly sterilized. The growth of resistant varieties offers the most promising means of control. Sweet cherry seedlings, known as Mazzards, are highly resistant and should be used as stocks on to which the desired commercial varieties may be budded or grafted when the seedlings are two to three years old. Bing and Royal Ann are highly susceptible, Lambert is more resistant, Duke and sour cherries are nearly immune.

Literature:

1911. Griffin, F. L. A bacterial gummosis of cherries. Science **34**: 615–616, 1911.

1913. Barss, H. P. Cherry gummosis. Oregon Agr. Col. Exp. Sta., Bien. Crop Pest and Hort. Rept. 1911–1912: 199–217, 1913.

1915. Barss, H. P. Bacterial canker of cherry and filbert disease. Science **42**: 581, 1915. (Abstract.) Also in Phytopath. **5**: 292, 1915.

1915. Barss, H. P. Bacterial gummosis or bacterial canker of cherries. Oregon Agr. Col. Exp. Sta., Second Bien. Crop Pest and Hort. Rept. 1913–1914, **2**: 224–240, 1915.

1915. Rees, H. L. Bacterial gummosis of cherries. Western Washington (Puyallup) Agr. Exp. Sta. Mo. Bul. 3(2): 12–16, 1915.

1918. Barrett, J. T. Bacterial gummosis of apricots—preliminary report. Mo. Bul. State Com. Hort. (California) **7**: 137–140, 1918.

1918. Barss, H. P. Bacterial gummosis of stone fruits. Monthly Bul. State Comm. Hort. (California) **7**: 121–136, 1918.

1922. Barrett, J. T. Notes on bacterial gummosis of stone fruits. Phytopath. **12**: 103–104, 1922. (Abstract.)

1922. Report of the College of Agriculture and the Agricultural Experiment Station of the University of California, 1st July, 1920 to 30th June, 1921: 62, 1922. *Pseud. cerasus* is reported on cherry in California. It also occurs on apricot.

1922. Report of the College of Agriculture and the Agricultural Experiment Station of the University of California, 1st July, 1921, to 30th June, 1922: 74, 135–136, 1922.

1923. Barss, H. P. Bacterial gummosis of cherry. Bien. Rept. Bd. Hort. Oregon 17: 152–154, 1923.

1928. Goldsworthy, M. C. The production of agglutinins by phytopathogenic bacteria. Phytopath. 18: 277–288, 1928. He used two strains of *Pseudomonas cerasus* 28 and 29 and *Bacterium maculicolum*.

1928. Smith, C. O. A study of citrus blast and some allied organisms. Phytopath. 18: 952, 1928. (Abstract.)

1930. Bergey's Manual of Determinative Bacteriology, p. 242, 1930. (3rd ed.)

Bacterium cerasi wraggi (Sackett) n. comb.

Motile; yellow; viscid; rod shaped—see *Bacterium cerasi*.

Synonymy:

Pseudomonas cerasi wraggi Sackett, 1925.

Phytomonas cerasi wraggi Sackett, 1925.

Symptoms: This organism is said to cause a blackening and shriveling of peduncles, circular brown spots on the leaves which drop out and give a shot hole appearance, olive brown discolorations around the lenticels of twigs and watery green spots on green fruit which become black and sunken as the disease progresses, producing an irregular, mummified cherry at maturity.

Host: *Prunus cerasus.*

Geographical distribution: Colorado.

Control: Lesions on both fruit and foliage can be greatly reduced by spraying with Bordeaux mixture or lime-sulphur but these sprays cause dwarfing of the treated parts.

Literature:

1917. Sackett, W. G. A bacterial disease of the wragg cherry. Preliminary note. Journ. Bact. 2: 79–80, 1917.

1924. Sackett, W. G. Bacterial disease of the wragg cherry. 37th Ann. Rept. of the Colorado Agricultural Experiment Station 1924: 18, 1924. The causal organism appears to be similar to, if not identical with, *Pseudomonas pruni.*

1925. Sackett, W. G. Report of the bacteriologist. A bacterial disease of wragg cherry. 38th Ann. Rept. Colorado Agr. Exp. Sta. for 1925: 16–20, 1925.

Bacterium cerealinum (Gentner) n. comb.

Motile by one to two polar flagella; 0.6–0.8 x 1.5–3.0μ; chains; spores formed; aerobic; gelatin not liquefied; a colorless dirty white at first and when a month old a dirty yellow on nutrient media; produces a red color in nutrient media; nitrates not reduced; starch digested.

Synonymy:

Bacillus cerealinum Gentner, 1920.

Pseudomonas cerealia (Gentner) Stapp, 1928.

Symptoms: This organism causes brown or black brown oval spots or blotches on the bases of the stalks, on nodes, upper internodes and leaves. The infected leaves yellow and die. Heads fill out poorly and glumes may split and leave the kernel naked. The insides of cracked kernels were red brown to brick red and the kernels were shriveled. The aleuron layer is colored red. Seedlings may be colored brownish or red by bacteria.

Hosts: *Hordeum vulgare, Secale cereale, Triticum* sp.

Geographical distribution: Bayern, Germany.

Control: Only disease-free seed should be used. Soaking the seed in 1 per cent formalin or sublimate solution will reduce but not eliminate the disease entirely.

Literature:

1920. Gentner, G. Eine Bakteriose der Gerste. Centralblatt für Bakt. 50: 428–441, 1920.

1928. Stapp, C. Schizomycetes (Spaltpilze oder Bakterien) in Sorauer's Handbuch der Pflanzenkrankheiten. 2 (fünfte auflage): 22, 1928. *Pseudomonas cerealia* G.

Bacterium cichori (Swingle) n. comb.

Rods; no spores; polar flagella; Gram negative; no indol; no diastatic action; gelatin not liquefied; nitrates not reduced; thermal death point 51°C.

Synonymy: *Phytomonas cichori* Swingle, 1925.

Symptoms: This organism causes a center rot of a yellowish olive color which affects chiefly the young inner leaves.

Host: *Cichorium intybus.*

Geographical distribution: Montana.

Literature:

1925. Swingle, D. B. Center rot of "French Endive" or wilt of chicory. (*Cichorium intybus* L.) Phytopathology 15: 730, 1925 (Abstract.)

Bacterium citri (Hasse) Doidge, 1916

Motile by one polar flagellum; 0.5–0.75 x 1.5–2.0μ; chains; capsules; no spores; aerobic; Gram negative; beef agar colonies circular, between straw yellow and amber yellow, slightly raised, glistening, with entire margins, viscid; yellow ring formed in bouillon; growth on potato cylinders somewhat raised, glistening, bright yellow with a narrow white zone around the margin which disappears as the surface of the cylinder becomes entirely covered with a thick, yellow, glistening, viscid mass; milk coagulated (Hasse, Wolf), no curd in litmus milk (Doidge); gelatin liquefied; blood serum slowly liquefied; no indol; no gas; no acid from dextrin, dextrose, galactose, glycerin, lactose, levulose, mannit, saccharose, starch, sodium citrate, sodium formate; nitrates not reduced; slight growth in Uschinsky's solution; strong diastatic action; ammonia produced.

Synonymy:

Pseudomonas citri Hasse, 1915;
Bacterium citri (Hasse) Jehle, 1917.;
Phytomonas citri (Hasse) Bergey et al., 1923.

Symptoms: The disease occurs on leaves, twigs, thorns, older limbs and fruit. Leaf lesions first appear as small, round, yellowish brown spots, translucent, oily, raised, and usually appearing on the lower surface first. The tissue ruptures in the center of the lesion giving a rough corky appearance. The spots increase in size to a quarter or half an inch in diameter with crater like depressions in the center and yellowish brown to green raised margins and watery yellow halos. Old lesions are brown corky, hard and lignified. Spots may occur on the midrib or petiole and result in defoliation. Similar round spots up to $\frac{1}{4}$ inch in diameter occur on thorns and twigs and may girdle the latter. On larger branches the spots are rougher, more irregular and more prominent. Lesions on fruits have much the same appearance as on the leaves except that the yellow halo is usually absent and crater like depressions are more noticeable. Fruit lesions become very corky and often show large fissures and cracks.

The organism enters through natural openings or wounds, occupying the intercellular spaces and dissolving the middle lamella.

Hosts: (natural) *Citrus grandis, Citrus sinensis;* (artificial) *Aigle marmelos, Atalantia ceylonica, Atalantia citrioides, Atalantia disticha, Casimiroa edulis, Chaetospermum glutinosa, Chalcas exotica, Citropsis schweinfurthi, Citrus* sp., *Citrus aurantifolia, Citrus aurantium, Citrus excelsa, Citrus hystrix, Citrus limonia., Citrus medica, Citrus mitis, Citrus nobilis, Citrus nobilis unshiu, Citrus trifoliata, Citrus aurantifolia × Citrus grandis, Citrus aurantifolia × Fortunella japonica, Citrus aurantifolia × Microcitrus australasica, Citrus grandis × Poncirus trifoliata, Citrus nobilis × Poncirus trifoliata, Citrus nobilis* var. *deliciosa × Citrus grandis, Claucena lansium, Clava hercules, Eremocitrus glauca, Evodia latifolia, Evodia ridleyei, Feronia limonia, Feronia lucida, Feroniella lucida, Fortunella crassifolia, Fortunella hindsii, Fortunella japonica, Fortunella margarita, Hesperethusa crenulata, Lansium domesticum, Melicope triphylla, Microcitrus australasica, Microcitrus australasica* var. *sanguinea, Microcitrus australis, Microcitrus garrowayi, Paramignya longipedunculata, Poncirus trifoliata, Poncirus trifoliata × Citrus aurantium, Poncirus trifoliata × Citrus sinensis, Poncirus trifoliata × Poncirus trifoliata, Toddalia asiatica, Zanthoxylum clava-hercules, Zanthoxylum fagara.*

Geographical distribution: Gulf states of United States, Hawaiian Islands, Mauritius, Japan, China (the disease is believed to have had its origin here, Fawcett and Lee 1926), Formosa, Philippines, Northern Australia, Indo China, Dutch East Indies, Java, Malay States, Siam, Ceylon, India, South Africa (Fawcett and Lee, 1926, report that the disease has been eradicated).

Control: The following measures are recommended: Exclusion by effective quarantine measures; eradication by destruction of infected trees and the observance of sanitary precautions; the growth of resistant varieties. Diseased twigs should be cut out as far as possible and burned and all affected fruit removed and buried or burned. Susceptible varieties should be sprayed with lime sulphur or Bordeaux mixture 4–4–50. According to Lee (1922), Bordeaux 4–4–50 must have oil emulsion added or red spider and sooty mold are greatly increased. Lime sulphur is less efficient than copper. When the disease is under control, one spraying each year or every second year is advisable but it is a waste of time to spray seriously infected nursery stock. For control of stem end and center rot of tomato see *Bact. malvacearum.*

Literature:

1914. Beattie, R. K. The citrus canker situation. Phytopath. 4: 397, 1914. (Abstract.) The disease was brought into Texas from Japan on Satsuma or *Citrus trifoliata* stock about 1910–1911 and has been nursery-distributed throughout the Gulf States.

1914. Berger, E. W. Citrus canker in the Gulf Coast country, with notes on the extent of citrus culture in the localities visited. Proc. 27th Ann. Meeting Florida State Hort. Soc., pp. 120–127, 1914. The disease was first discovered by Berger on 20,000 young nursery trees in Florida in 1912.

1914. Berger, E. W., H. E. Stevens, and F. Stirling. Citrus canker II. Florida Agr. Exp. Sta. Bul. 124: 27–53, 1914. (Abstr. in Agric. News (Barbados) 14: No. 334, p. 62, 1915.) This is one of the first reports and gives the early history of the disease. Mississippi, Louisiana, Texas and New Mexico are added to the list of states in which the disease occurs.

1914. Berger, E. W. Citrus canker. Florida Grower 10: 9, 1914.

1914. Berger, E. W. Citrus canker history. Florida Grower 11: 14–15, 1914.

1914. Byrd, H. Copper as treatment for citrus canker a failure. Florida Grower 11: 22–23, 1914.

1914. Edgerton, C. W. Citrus canker. Louisiana Agr. Exp. Sta. Bul. 150: 10 pp., 1914.

1914. Fawcett, H. S. Citrus canker in Florida and the Gulf States. Mo. Bul. State Com. Hort. (California) 3: 512–513, 1914.

1914. Johnston, J. R. The citrus canker. Modern Cuba 2: 63, 1914.

1914. Massey, A. B. Citrus canker. Phytopath. 4: 397, 1914. (Abstract.) The writer states that the causal organism has been proved to be a species of *Phoma*.

1914. Stevens, H. E. Citrus canker. A preliminary bulletin. Florida Agr. Exp. Sta. Bul. 122: 113–118, 1914. (Abstr. in Agric. News (Barbados) 14: 62, 1915.) This is the first printed report of the disease in the United States and it is here named "canker." The disease was found in northern and southern Florida and in Alabama. As means of control the writer recommends eradication and exclusion of infected nursery stock. A species of *Phyllosticta* is reported as the probable cause of the disease.

1914. Stevens, H. E. Citrus canker and picking implements. Florida Grower 11: 15, 1914. Methods of sterilizing instruments and boxes are given.

1914. Stevens, H. E. No cure for citrus canker. Florida Grower 11: 17, 1914.

1914. Wolf, F. A., and A. B. Massey. Citrus canker. Alabama Agr. Exp. Sta. Circ. 27: 97–102, 1914. A species of *Phoma* is reported as the cause of the disease.

1915. Berger, E. W. Citrus canker. Its origin, distribution and spread. Proc. Ann. Meeting Florida State Hort. Soc. 28: 71–80, 1915.

1915. Burbank, M. S. Citrus canker in north Dade County. Proc. Ann. Meeting Florida State Hort. Soc. 28: 100–103, 1915.

1915. Fawcett, H. S. Citrus diseases of Florida and Cuba compared with those of California. California Agr. Exp. Sta. Bul. 262: 169–174, 1915.

1915. Hasse, C. H. *Pseudomonas citri*, the cause of citrus canker. (A preliminary report.) The writer isolated a bacterial organism with which she reproduced the canker symptoms and established the bacterial nature of the disease. Journ. Agr. Res. 4: 97–100, 1915.

1915. Henry, A. M. Some ways of spreading citrus canker. Proc. Ann. Meeting Florida State Hort. Soc. 28: 90–91, 1915.

1915. Krome, W. J. What remains to be done before we are finally rid of citrus canker. Proc. Ann. Meeting Florida State Hort. Soc. 28: 95–99, 1915.

1915. Rorer, J. B. Citrus canker. Dept. Agr. Trinidad and Tobago Bul. 14: 130–131, 1915.

1915. Stevens, H. E. Report of plant pathologist. Citrus canker. Florida Agr. Exp. Sta. Rept., 85–91, 1915. *Phyllosticta* sp. was for some time thought to be the cause of the disease but recent investigations have proven that *Pseudomonas citri* is the causal organism.

1915. Stevens, H. E. Nature and cause of citrus canker. Florida Grower 11: 5–6, 1915. An imperfect fungus is thought to be the cause of the disease.

1915. Stevens, H. E. Cause of citrus canker. Florida Grower 11: 15, 1915. *Pseudomonas citri* Hasse.

1915. Stevens, H. E. Nature and cause of citrus canker. Proc. Ann. Meeting, Florida Hort. Soc. 28: 81–82, 1915.

1915. Stevens, H. E. Citrus canker III. Florida Agr. Exp. Sta. Bul. 128: 20 pp., 1915. He confirmed Hasse's work and further established the bacterial nature of the disease.

1915. Stirling, F. On the firing line before citrus canker. Proc. Ann. Meeting Florida State Hort. Soc. 28: 85–89, 1915.

1915. Swingle, W. T. Citrus canker in Philippines. U. S. Dept. Agr. Departmental Circ. 1: 8, 1915. The disease occurs on kumquat in Japan.

1915. Tenny, L. S. Citrus canker situation. Florida Grower 11: 20–21, 1915.

1915. Tenny, L. S. The relation of the Florida Growers and shippers to the citrus canker work. Proc. Ann. Meeting Florida State Hort. Soc. 28: 104, 1915.

1915. U. S. Department of Agriculture. Citrus canker in Philippines. In U. S. Dept. Agr., Circ. 5: 8, 1915.

1916. Cuba. Laws, statutes, etc. (citrus canker). Modern Cuba, 4: No. 7, 14–22, 1916. There is no citrus canker in Cuba.

1916. Doidge, E. M. Citrus canker in South Africa. South African Fruit Grower 3: 265–268, 1916. (Paper read before S. African Assoc. for Adv. Sci. Maritzburg, July, 1916.) The infection in South Africa is traced directly to the importation of grapefruit

trees from Florida in 1905–1906. The disease was first observed in 1908 and in spite of efforts to check its progress the whole of the 1909 lemon and orange crops were destroyed.

1916. Doidge, E. M. The origin and cause of citrus canker in South Africa. Union So. Africa, Dept. Agric. Science Bul. 8: 20 pp., 1916.

1916. Doryland, E. D. Citrus canker investigations at the Singalong Exp. Sta. Philippine Agr. Rev. **9**: 133–135, 1916.

1916. Edgerton, C. W., and J. B. Garrett. Citrus canker. Louisiana Agr. Exp. Sta. Circ. 15: 11 pp., 1916.

1916. Fawcett, H. S. Citrus canker in Florida and the Gulf States. Mo. Bul. State Comm. Hort. (California) 3: 512–513, 1916.

1916. Grossenbacher, J. G. Some bark diseases of citrus trees in Florida. Phytopath. **6**: 29–50, 1916.

1916. Jehle, R. A. Citrus canker studies. Florida Grower **14**: No. 20, 9–10, 15, 1916.

1916. Jehle, R. A. Means of identifying citrus canker. Quart. Bul. State Plant Bd. Florida 1: 2–10, 1916.

1916. Mackie, D. B. Observations on the distribution of citrus canker. Philippine Agr. Rev. **9**: 278–281, 1916.

1916. Nelson, E. Eradication on a large scale. Phytopath. **6**: 114, 1916. (Abstract.)

1916. Newell, W. Sanitary precautions to be employed in citrus properties. Florida Grower **14**: 11–18, 1916.

1916. Newell, W. Citrus canker situation. Proc. 29th Ann. Meeting Florida State Hort. Soc. 1916: 47–51, 1916.

1916. Newell, W. The dying of citrus trees: a comparison. Agr. News (Barbados) **15**: 366–367, 1916.

1916. Webster, P. J. Notes on citrus canker. Philippine Agr. Rev. **9**: 155–157, 264–265, 1916.

1916. Wolf, F. A. Citrus canker. Journ. Agr. Res. **6**: 69–99, 1916. The writer also isolated the organism and reproduced the disease, adding to our knowledge of the cultural characters of the organism.

1917. Bokura, U. Inspection of citrus stock with special attention to citrus canker. Journ. Plant Protection (Tokyo) **4**: 838–843, 1917.

1917. Clausen, C. P. Citrus culture in Japan, China, and Formosa. Monthly Bul., State Comm. Hort. (California) 6: 379–383, 1917. The writer states that much injury is done to trees in Japan by citrus canker. Bordeaux spray is used but with doubtful results.

1917. Doidge, E. M. A bacterial spot of citrus. Ann. Appl. Biol. **3**: 78, 1917. This article contains a comparative table of *Bacillus citrimaculans*, *Bacterium citriputeale*, *Pseudomonas citri*.

1917. Doryland, E. D. Effects of formalin-bordeaux mixture on citrus canker. Philippine Agr. Rev. **10**: 51–54, 1917.

1917. Evans, I. B. P. Citrus canker. Union So. Africa Dept. Agr. Local Ser. 30: 3 pp., 1917. (Also in Dutch.)

1917. Hoyt, A. S. Some facts about the eradication of citrus canker. Mo. Bul. State Com. Hort. (California) 6: 378–390, 1917.

1917. Jehle, R. A. Characteristics of citrus canker and of the causal organism. Quart. Bul. State Plant Bd. Florida 1: 24–47, 1917. Varieties are listed in the order of susceptibility. The only effective control measures were found to be exclusion by quarantine and other means and eradication and destruction of infected trees.

1917. Jehle, R. A. Citrus canker investigations at the Florida Tropical Laboratory. Phytopath. 7: 58–59, 1917. (Abstract.)

1917. Jehle, R. A. Susceptibility of non-citrus plants to *Bacterium citri*. Phytopath. 7: 339–344, 1917. Infections were produced by inoculation with *Bact. citri* on *Zanthoxylum fagara* (L) Sarg. and it has occasionally been found on the wild lime in Dade Co. hammocks, but there was no abundance of natural infestation.

1917. Kellerman, K. F. Cooperative work for eradicating citrus canker. U. S. Dept. Agric. Yearbook, 1916: 267–272, 1917.

1917. Lee, H. A. A new bacterial citrus disease. Journ. Agr. Res. 9: 1–8, 1917.

1917. Newell, W. Citrus canker. Mo. Bul. State Com. Hort. (California) 6: 263–268, 1917.

1917. Webster, P. J. Additional observations on the citrus fruits in the Philippines. Philippine Agr. Rev. 10: 104–115, 1917.

1917. Webster, P. J. Notes on citrus canker affection at the Lamao Exp. Sta. 10: 253–260, 1917.

1918. Doidge, E. M. The characteristics of citrus canker and its eradication. Union So. Africa, Dept. Agr. Bul. 3: 9 pp., 1918. Previous publications dealing with citrus canker in South Africa: p. 9.

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1918. Hill, G. F. History of citrus canker in the Northern Territory (with notes of its occurrence elsewhere). Bul. North Terr. Australia 18: 8 pp., 1918. Caption title: History of citrus canker in Australia, with a brief account of the occurrence of the disease in the United States of America and South Africa. Its identity was definitely established in 1916 although the disease had been known in Australia for several years.

1918. Jehle, R. A. Susceptibility of *Zanthoxylum clava-hercules* to *Bacterium citri*. Phytopath 8: 34–35, 1918.

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1918. Peltier, G. L. Susceptibility and resistance to citrus canker of the wild relatives, citrus fruits, and hybrids of the genus *Citrus*. Journ. Agr. Res. 14: 337–357, 1918. The more important wild relatives, species, varieties, and hybrids of citrus were inoculated with *Ps. citri* in the greenhouse. The genera *Fortunella, Eremocitrus*, and *Microcitrus* show some resistance. *Poncirus* is extremely susceptible. All species and varieties of citrus tested are susceptible.

1918. Peltier, G. L., and D. C. Neal. Overwintering of the citrus canker organism in the bark tissue of hardy citrus hybrids. Journ. Agr. Res. 14: 523–524, 1918.

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1918. Tanaka, T. A brief history of the discovery of citrus canker in Japan and experiments in its control. Quart. Bul. State Plant Bd. Florida 3: 1–15, 1918.

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1919. Report for quarter ending June 30, 1919. Quart. Bul. Florida State Plant Bd. 3: 134–135, 1919.

1919. Kellerman, K. F. The eradication of the citrus canker. Journ. Washington Acad. Sci., pp. 143–145, March 4, 1919. (Abstract of paper presented to Botanical Soc. Washington, Oct. 1, 1918.)

1919. Lee, H. A., and E. D. Merrill. The susceptibility of a non-rutaceous hosts to citrus canker. Science 49: 499–500, 1919.

1919. Newell, W. Citrus canker eradication in Florida. Month. Bul. Stat. Comm. Hort. California 8: 395–399, 1919.

1919. Newell, W. Citrus canker eradication in the state of Florida. California Citrogr. 4: 313, 323, 1919.

1919. Newell, W. Future protection against citrus canker. Proc. Florida State Hort. Soc. 32 (1919): 134–141, 1919.

1919. Reinking, O. Philippine plant diseases. Phytopath. 9: 118–119, 1919. *Bacterium citri* Hasse. On *Citrus* sp., *Citrus nobilis, Citrus grandis, Citrus hystrix, Citrus medica, Citrus torosa, Citrus japonica, Citrus mitis*.

1919. Reinking, O. A. Diseases of economic plants in southern China. The Philippine Agric. 8: 109–134, 1919. *Pseudomonas citri* Hasse.

1920. Doidge, E. M. The eradication of citrus-canker. Journ. Dept. Agr. So. Africa 1: 124–134, 1920.

1920. Fulton, H. R. Decline of *Pseudomonas citri* in the soil. Journ. Agr. Res. 19: 5, 207–223, 1920.

1920. Florida State Plant Board Rept. for quarter ending Dec. 31, 1919. Quart. Bul. Florida State Plant Bd. 4: 35–36, 1920.

1920. Lee, H. A. Behavior of the citrus-canker organism in the soil. Journ. Agr. Res. 19: 189–206, 1920.

1920. Lee, H. A. Action of some fungicides on the citrus canker organism. A progress report. Philippine Journ. Sci. 17: 325–341, 1920 (1921).

1920. Peltier, G. L. Influence of temperature and humidity on the growth of *Pseudomonas citri* and its host plants and on infection and development of the disease. Journ. Agr. Res. 20: 447–506, 1920.

1920. Peltier, G. L., and W. J. Frederich. Relative susceptibility to citrus canker of different species and hybrids of the genus *Citrus*, including the wild relatives. Journ. Agr. Res. 19: 339–362, 1920.

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1921. Lee, H. A. The increase in resistance to citrus canker with the advance in maturity of citrus trees. Phytopath. 11: 70–73, 1921.

1921. Lyon, H. L., and H. A. Lee. Citrus canker in the Hawaiian Islands. Phytopath. 11: 377, 1921. (Jan., 1922.) Citrus canker is reported for the first time on the islands of Oahu and Kanai-Hawaii.

1921. McLean, F. T. A study of the structure of the stomata of two species of *Citrus* in relation to citrus canker. Bul. Torr. Bot. Club 48: 101–106, 1921.

1921. McLean, F. T., and H. A. Lee. The resistance to citrus canker of *Citrus nobilis* and a suggestion as to the production of resistant varieties in other citrus species. Phytopath. 11: 109–114a, 1921.

1921. Reinking, O. Philippine Agric. 9: 121–179, 1921. The writer lists the species in the order of susceptibility to citrus canker in the east.

1922. Doidge, E. M. Rept. Div. Bot. and Plant Path. Journ. Dept. Agric., Union South Africa 5: 493, 1922. Citrus canker eradication has progressed so satisfactorily that only four infected trees were found during the year and these were all on one farm.

1922. Lee, Henry Atherton, and A. Shino. Citrus canker control experiments in Japan. Philippine Journ. Sci. 20: 121–150, 1922. The writers conclude that control can be effected on citrus fruits of the general susceptibility of the Washington naval orange which

is less susceptible than limes or grapefruit but more susceptible than the Mediterranean sweet orange, satsuma, mandarin, lemon, citron, kumquat and calamondin.

1922. Lee, H. A. Relation of age of citrus tissues to the susceptibility to citrus canker. Philippine Jour. Sci. **20**: 331–339, 1922. In Japan fruits of the Washington naval orange are immune to stomatal infection after 85 days and to wound infection after 110 to 120 days.

1922. McLean, F. T., and H. A. Lee. Pressures required to cause stomatal infections with the citrus-canker organism. Philippine Journ. Sci. **20**: 309–320, 1922. In the mandarin orange pressure is necessary to bring about stomatal infection. In grapefruit this pressure is not necessary.

1923. Bergey's Manual of Determinative Bacteriology, p. 181, 1923.

1923. Stirling, Frank. The present status of citrus canker. Citrus Industr. **4**: 22, 24, 1923.

1924. Peltier, G. L. Present status of citrus canker problem. American Fruit Grower **44**: 5, 7, 19, 21, 25, 1924. Only eleven infected trees in 900,000 groves were found in 1923 in Florida. Similar conditions occur in Alabama and Mississippi. Kumquats are highly resistant, all American grapefruit are extremely susceptible, mandarins are resistant.

1924. Peltier, G. L., and W. J. Frederich. Further studies on the relative susceptibility to citrus canker of different species and hybrids of the genus *Citrus*, including the wild relatives. Jour. Agr. Res. **28**: 227–239, 1924.

1925. Departmental activities: botany. Journ. Dept. Agr. S. Africa **10**: 381–382, 1925. Citrus canker was reported in a test orchard replanted in 1922, four years after the eradication of all infected trees in 1918, and in 1924 one grapefruit tree was found infected, showing that the organism could remain alive in infested orchards for at least six years after the removal of the trees.

1925. Report of the Chief of the Bureau of Plant Industry for the fiscal year ended June 30, 1925. U. S. Dept. Agric., B. P. I., Washington, D. C., 36 pp., 1925. Citrus canker has been practically eliminated. Mississippi is free from the disease. No infection has appeared in Alabama since 1924, and none has been reported from Texas during the past year. Infected trees found in Florida in March, 1925, have been destroyed. Scattered infections are still found in Louisiana.

1925. Report of Plant Commissioner for the biennium ending June 30, 1924. Quart. Bul. State Plant Board Florida 9: 59–86, 1925. "The total cost of the citrus canker (*Pseudomonas citri*) campaign in Florida since its inception in 1914, is estimated at over $1,718,000, excluding the value of the trees destroyed in the course of the work. However, since the value of the Florida citrus plantations is calculated, at a conservative estimate, at $250,000,000, there can be no question as to the utility of the work of eradication" R. A. M. **4**: 401, 1925.

1926. Brown, N. A. A stem-end and center rot of tomato caused by various unrelated organisms. Journ. Agric. Res. **33**: 1009–1024, 1926. The disease can scarcely be detected on the outside of the fruit, while the central core, including portions of the seeds, is a mass of hard, dark tissue. Causes losses in shipments of green tomatoes. Organisms producing decay readily: *Bacterium malvacearum* E. F. S., *Bacterium marginale* Brown, *Bacterium tumefaciens* Smith and Townsend, *Bacterium savastanoi* E. F. S., *Bacterium campestre*, E. F. S., *Bacterium viridilividum* Brown, and fungi. Organisms which produce the disease with difficulty: *Bacterium citri* Hasse, *Bacillus coli communis* Esch., *Bacterium vitians* Brown, *Bacillus mycoides* Flügge. (See Brown, N. A. A new bacterial disease of tomato fruits. Science **62**: 12–13, 1925.)

1926. Fawcett, H. S., and H. A. Lee. Citrus diseases and their control. pp. 212–222, 1926.

1926. Peltier, G. L., and W. J. Frederich. Further studies on the overwintering of *Pseudomonas citri*. Journ. Agr. Res. **32**: 335–345, 1926.

1926. Peltier, G. L., and W. J. Frederich. Effects of weather on the world distribution and prevalence of citrus canker and citrus scab. Journ. Agr. Res. **32**: 147–164, 1926. Temperature is not a limiting factor in the development of canker. The seasonal distribution of rainfall appears to be a more important factor in limiting the disease than its amount or frequency.

1927. Link, G. K. K., and K. L. Hull. Smoothness and roughness and spontaneous agglutination of *Bacterium citri*, *Bact. medicaginis* var. *phaseolicola*, *Bact. phaseoli sojense* and *Bact. tumefaciens*. Bot. Gaz. **73**: 412–419, 1927

1928. Link, G. K. K., and A. DeS. Link. Further agglutination tests with bacterial plant pathogens. I. *Bacterium campestre-Bact. phaseoli* group; *Bact. medicaginis* var. *phaseolicola; Bact. tumefaciens*. Bot. Gaz. **85**: 178–197, 1928.

1928 Department of citrus canker eradication. State Plant Board of Florida. The Monthly Bulletin 13: 28, 1928. Gives a table showing the number of citrus grove trees found infected with canker during each month from the beginning of the eradication work to July 31, 1928.

1929. Fulton, H. R., and J. J. Bowman. Infection of fruit of citrus by *Pseudomonas citri*. Journ. Agr. Res. **39**: 403–426, 1929.

Bacterium conjac (Uyeda) n. comb.

Motile by one to four polar flagella; 0.75–1.0 x 1.5μ; no spores; no capsules; Gram positive; gelatin colonies circular to irregular and light yellow; gas from glucose; pellicle formed in bouillon; milk coagulated; conjac liquefied; hydrogen sulphide and indol produced; nitrates reduced; 24°C. is a favorable temperature for growth.

Synonymy:

Pseudomonas conjac Uyeda, 1910.

See *Bacterium antirrhini.*

Symptoms: The leaves turn brown from the top, later change to black brown and finally droop. In severe cases the petioles are attacked, the leaves fall and the tuber shrivels or rots.

Host: *Amorphophallus konjac.*

Geographical distribution: Japan.

Control: Washing the tubers with a dilute formalin solution and spraying the leaves with Bordeaux were found to be effective means of control.

Literature:

1905. Koch, K. Siehe Matsumura. I. Index plantarum japonicarum 2: 169, 1905.
1910. Uyeda, Y. Konnyoku Yoko-byo Saikin oyobi "Mannan" wo yokwai shuru Saikinrui (On the conjac leaf-blight and some Mannan-liquefying bacteria). Bot. Mag. Tokyo 24: 177–182, 1910. (In Japanese.)

Bacterium coronafaciens Elliott, 1920

Average measurements 0.68 x 2.40μ; capsules; chains; no spores; motile by one to several polar flagella; aerobic; Gram negative; not acid fast; beef agar colonies round to irregularly circular, flat with slightly raised margins, white, smooth to slightly contoured, agar somewhat greened; moderate clouding in beef bouillon and a flocculent white pellicle; gelatin liquefied; milk may be cleared without formation of a curd but usually a soft curd is formed followed by slow peptonization; litmus in milk reduced; ammonia produced; no indol; hydrogen sulphid produced; slight reduction of nitrates; moderate diastatic action; no gas; acid from sucrose, dextrose, levulose; good growth in Uschinsky's and Fermi's solutions, scant in Cohn's; optimum temperature 22°C.; maximum 33–35°C.; minimum 1°C.; thermal death point about 48°C.

Synonymy:

Bacillus avenae Galloway, 1892 (named by Russell). a non-fluorescent.

~~*Pseudomonas avenae* Manns, 1909.~~ No! —

~~*Bacillus avenae* Manns, 1909.~~

Phytomonas coronafaciens (Elliott) Bergey et al., 1923.

Pseudomonas coronafaciens (Elliott) Stapp, 1928.

Phytomonas avenae (Manns) Bergey et al., 1930.

Symptoms: This is a spot disease which appears on the first leaves of seedlings and spreads to leaves, leaf sheaths and glumes as the plants develop. Lesions are first visible as light green oval spots 4–5 mm. in diameter with central sunken points of infection about the stomata. The centers of infection become gray or brown, dry tissue one to several millimeters in diameter. The halo-like margin spreads rapidly to a centimeter or more in diameter, becoming uniformly lighter green to yellow or showing concentric markings of different shades of green and yellow. These halo-like margins may be prolonged at one end into points one to several centimeters long, or may extend as yellow streaks through the center or along the margin to the tip of the leaf. Marginal infections are common forming crescent-shaped lesions. The tissues are not watersoaked and exudate does not

occur. Coalescing lesions may produce a general yellowing followed by a breaking across of leaf blades or a shriveling and drying of tips and margins. Halo blight, blade blight.

Hosts: (natural) *Avena sativa;* (artificial) *Hordeum vulgare, Secale cereale, Triticum aestivum.*

Geographical distribution: General throughout the oat-growing sections of United States, Canada and probably in Wales and England.

Control: Treatment of seed for 3 hours in 1–320 formalin greatly reduces the amount of blight. A hot air treatment for 30 hours at 100°C. destroys all seed infection.

Literature:

1890. Galloway, B. T. Preliminary notes on a new and destructive oat disease [Bacterial]. Proc. Am. Assoc. Adv. Sci. for 1890, **39**: 333, 1891. (Only a six-line abstract of a paper which probably contained interesting statements regarding the disease and the parasite.) Also in Bot. Gazette **15**: 228, 1890 (only a four line abstract).

1890. Galloway, B. T., and E. A. Southworth. Preliminary notes on a new and destructive oat disease. Journ. of Mycology **6**: 72–73, 1890. (Attention was first called to this disease in this paper. They state that bacteria were isolated which 5 days after inoculation with pure cultures reproduced the characteristic signs of the disease. The organism was reisolated but no details as to methods and no description of the organism are given.)

1891. Galloway, B. T., and E. A. Southworth. Preliminary notes on a new and destructive oat disease. (In Director's report) Delaware Agr. Exp. Sta. **4**: 12–15, 1891.

1892. Russell, H. L. Bacteria in their relation to vegetable tissue. A dissertation presented to the Board of University Studies of the Johns Hopkins University for the Degree of Doctor of Philosophy, pp. 13, 38, 1892.

1909. Manns, T. F. The blade blight of oats, a bacterial disease. Ohio Agr. Exp. Sta. Bul. 210, Oct., 1909.

1918. Elliott, C. Bacterial oat blight. Phytopath. **8**: 489–490, 1918 (note).

1920. Elliott, C. Halo-blight of oats. Journ. Agr. Res. **19**: 139–172, 1920.

1922. Cotton, A. D. Report on the occurrence of fungus bacterial and allied diseases on crops in England and Wales for 1920–1921. Ministry of Agric. and Fish., (Gt. Brit.) Misc. Pub. No. 38: 17, 1922. Reported from Cambridge, Leamington, Surrey, Aberystwyth. The organism was not isolated.

1923. Bergey's Manual of Determinative Bacteriology, pp. 180–181, 1923.

1923. Reddy, C. S., and J. Godkin. A bacterial disease of brome-grass. Phytopath. **13**: 75–85, 1923.

1923. Sampson, K., and D. W. Davies. Incidence of fungus diseases on oat varieties in the seasons 1921–22. Preliminary investigations

with oats. Welsh Plant Breeding Station Aberystwyth, Ser. C, No. 3, 1921–22: 55–57, 1923. They record what is very probably the same thing as our halo blight but they had not isolated the causal organism.

1925. Brookes, R. St. John, K. Nain and M. Rhodes. The investigation of phytopathogenic bacteria by serological and biochemical methods. Journ. Path. and Bakt. 28: 203–209, 1925. (See *Bacillus carotovorus.*)

1927. Elliott, C. Bacterial stripe blight of oats. Journ. Agr. Res. 35: 811–824, 1927.

1928. Stapp, C. Schizomycetes (Spaltpilze oder Bakterien). In Sorauer's Handbuch der Pflanzenkrankheiten 2 (fünfte auflage): 20–21, 1928.

1929. Riker, A. J. Studies on the influence of environment on infection by certain bacterial plant parasites. Phytopath. 19: 96, 1929. (Abstract.)

1930. Bergey's Manual of Determinative Bacteriology, p. 242, 1930. (3rd ed.)

Bacterium coronafaciens atropurpureum Reddy and Godkin, 1923

0.72–0.81 x 1.92–2.25μ; obligate aerobe; thermal death point 50°–51°C.; no growth at 0°C.; remained alive in dried condition on cover glasses up to 198 hours; no growth in 0.1 per cent citric, tartaric and malic acid; clouding in neutral beef-peptone bouillon up to and including 7 per cent sodium chloride. Otherwise identical with *Bact. coronafaciens.*

Synonymy: *Pseudomonas coronafaciens* var. *atropurpurea* (Reddy and Godkin) Stapp, 1928.

Symptoms: This is a spot disease causing circular to elliptical water-soaked light olive green spots with brown centers on leaves and glumes. These spots later become linear and dark chocolate or purplish brown to black. The spots may or may not be accompanied by yellow halos. The lesions may coalesce to destroy the entire leaf surface. Upper nodes are sometimes killed, and panicles wither and die. Infection takes place through wounds and stomata and is at first intercellular and later intracellular in the parenchyma.

Hosts: (natural) *Agropyron repens, Bromus inermis;* (artificial) *Avena sativa, Bromus* sp. (23 species).

Geographical distribution: Wisconsin, North Dakota, South Dakota.

Control: It is suspected that the disease is transmitted on the seed and may overwinter in lesions on dead brome grass.

Literature:

1923. Reddy, C. S., and J. Godkin. A bacterial disease of brome grass. Phytopathology 13: 75–86, 1923.

1928. Stapp, C. Schizomycetes (Spaltpilze oder Bakterien). In Sorauer's Handbuch der Pflanzenkrankheiten. 2 (fünfte auflage): 38–39, 1928.

Bacterium cucurbitae Bryan, 1926

Motile by one polar flagellum; 0.45–0.6 x 0.5–1.3μ; Gram negative; beef agar colonies convex, wax-yellow with internal concentric markings; gelatin slowly

liquefied; nitrates not reduced; feeble or no growth in Cohn's solution; moderate growth in Uschinsky's; in beef bouillon a heavy bright yellow rim is formed and often a pellicle, both composed of coarse pseudozoogloeal masses; milk curdled and peptonized; litmus reduced; growth on potato cylinders abundant, destroying the starch and filling the water with dense yellow slime.

Synonymy: *Phytomonas cucurbitae* (Bryan) Bergey et al., 1930.

Symptoms: This is a spot disease causing leaf lesions with conspicuous bright yellow halos. The spots are at first small and round, becoming angular as they are limited by leaf veins, and finally coalescing to form large brown areas with yellow margins which may involve the whole blade. Some small spots become thin and translucent but do not tear or drop out. Bacterial exudate is present.

Hosts: *Cucurbita maxima, Cucurbita pepo, Cucurbita pepo condensa.*

Geographical distribution: New York.

Literature:

1926. Bryan, M. K. Bacterial leafspot on hubbard squash. Science **63**: 165, 1926.

1928. Bryan, M. K. Squash of Hubbard variety attacked by new leaf spot. Yearbook, U. S. Dept. Agric. 1927: 599–600, 1928.

1928. Link, Geo. K. K., and A. DeS. Link. Further agglutination tests with bacterial plant pathogens. I. *Bacterium campestre-Bact. phaseoli* group; *Bact. medicaginis* var. *phaseolicola; Bact. tumefaciens.* Bot. Gaz. **85**: 178–197, 1928.

1930. Bergey's Manual of Determinative Bacteriology, p. 241, 1930. (3rd ed.)

Bacterium delphini (E. F. Smith) Bryan, 1924

Motile by one to six bipolar flagella; 0.6–0.8 x 1.5–2.0μ; short chains; capsules; no spores; aerobic; Gram negative; not acid fast; beef agar colonies round white, transparent, opalescent, slightly convex, sometimes slightly umbonate, smooth glistening, finely granular, sometimes slightly viscid, the agar blue-green fluorescent; growth on potato cylinders dirty white becoming pale tan colored, slimy; diastatic action weak; good growth in beef bouillon with heavy pellicle and blue-green fluorescence; gelatin liquefied and greened; nitrates not reduced; milk cleared without coagulation; litmus in milk blued and then reduced; ammonia produced; no indol; no hydrogen sulphide; no gas; acid from dextrose, sucrose, galactose, levulose; grows well in Uchinsky's, Fermi's and Cohn's solutions; optimum temperature 25°C.; maximum 30°C.; minimum 1°C. or less; thermal death point 50°C.

Synonymy:

Bacillus delphini E. F. Smith, 1904.
Bacterium delphinii (E. F. Smith) Bryan, 1924.
Pseudomonas delphinii (E. F. Smith) Stapp, 1928.
Phytomonas delphinii (E. F. Smith) Bergey et al., 1930.

Symptoms: This is a spot disease causing irregular tarry black areas on leaves, flower buds, petioles and stems and resulting in more or less distortion. The organism enters through stomata of the lower epidermis or water pores at the tips of serratures. Very young lesions are water-soaked but older lesions show no water-soaked tissues. In later stages spots may coalesce, forming large

black areas involving almost the entire leaf blade. Leaf lesions are more or less concentrically marked. Black spot, black disease.

Hosts: *Aconitum napellus*, *Delphinium* sp.

Geographical distribution: Maine, New Hampshire, Massachusetts, Connecticut, New York, Pennsylvania, Illinois, Oregon, France.

Control: Assuming that the organism winters over in the soil, it is suggested that the disease may be controlled by removal and burning of all diseased material and by spraying early leaves and surrounding soil with alkaline Bordeaux mixture. Simonet (1927) recommends propagation of plants in an acid soil.

Literature:

1904. Smith, Erwin F. Bacterial leaf spot diseases. Science (n. s.) **19**: 417, 1904.

1905. Smith, Erwin F. Bacteria in relation to plant diseases **1**: fig. 127, 1905.

1909. Clinton, G. P. Bacterial spot of larkspur (*Bacillus delphini* Sm.). Connecticut Agr. Exp. Sta. Report for 1907–08, Rept. of Botanist for 1908; 862–863, 1909.

1911. Smith, E. F. Bacteria in relation to plant diseases **2**: 61–62, 1911.

1924. Bryan, M. K. Bacterial leaf spot of delphinium. Journ. Agr. Res. **28**: 261–270, 1924.

1924. Gloyer, W. O., and H. Glasgow. Cabbage seedbed diseases and delphinium root rots: their relation to certain methods of cabbage maggot control. New York (Geneva) Agr. Exp. Sta. Bul. 513: 30–31, 1924. Bacterial blight (*Bacillus delphinii*) on delphinium was controlled by pruning back the plants to soil level and one application of 1 gm. mercuric chloride and 1 gm. sodium nitrate per 2,000 cc. of water.

1925. Brookes, R. St. John, K. Nain and M. Rhodes. The investigation of phytopathogenic bacteria by serological and biochemical methods. Journ. Path. and Bakt. **28**: 203–209, 1925. See *B. carotovorus*.

1925. Simonet, M. Notes de pathòlogie végétale. Journ. Soc. Nat. D'Hort. de France. Ser. 4, **26**: 422–425, 1925. *Bact. delphini* is recorded in the vicinity of Paris.

1927. Bryan, M. K. Beef infusion versus beef extract media. Phytopath. **17**: 413–414, 1927. Note. *Bact. delphini* fluorescent on beef infusion peptone agar.

1927. Simonet, M. Une maladie nouvelle des delphinium. Revue Horticole (Paris) **99**: 405–406, 1927.

1928. Stapp, C. Schizomycetes (Spaltpilze oder Bakterien). In Sorauer's Handbuch der Pflanzenkrankheiten. 2 (fünfte auflage): 106–107, 1928.

1930. Bergey's Manual of Determinative Bacteriology, p. 242, 1930. (3rd ed.)

Bacterium (?) dendrobii Pavarino, 1912

No plates having been poured there is no certainty that he was working with pure cultures. He states that he obtained infection by pure culture inoculation.

2.0–4.0 x 0.4–0.6μ; Gram positive; facultative anaerobe; citron yellow on agar; gelatin not liquefied.

Symptoms: This organism is said to cause a general withering of leaves and shoots. The disease progresses through the vascular tissue, the surrounding tissue turning dark and the branches wilt and break over at points where the tissue has become softened and disorganized.

Host: *Dendrobium nobile.*

Geographical distribution: Italy.

Literature:

1912. Pavarino, L. Avvizzimento del *Dendrobium nobile* Lindl. Rivista di Patologia Vegetale. Anno 5, (16–17): 241–242, 1912.

Bacterium destructans (Potter) Nakata, 1922

Motile by one polar flagellum; 0.8 x 3.0μ; aerobic; Gram negative; gelatin rapidly liquefied; agar colonies white, glistening, circular; diastatic action present. According to Harding and Morse (1909), this organism is peritrichiate; clouds bouillon with formation of a pellicle; grows in Uschinsky's solution; does not grow in Cohn's; milk is coagulated and cleared; indol produced; nitrates reduced.

Synonymy:

Pseudomonas destructans Potter, 1899.

Phytomonas destructans (Potter) Bergey et al., 1930.

Potter (1899) isolated an organism from white rot of turnip which he described as having a single polar flagellum. Harding and Morse (1909) received two cultures of this organism from Potter both of which had peritrichiate flagella. They found no essential differences between Potter's organism and *Bacillus carotovorus.* Johnson and Adams (1910) attributed the soft rot of turnip in Ireland to a polar flagellate organism (*Ps. destrucans*) but thought it was probably identical with *Bacillus oleraceae.* Priestley and Lechmere found peritrichiate flagella and concluded that *Ps. destructans* and *Bacillus oleraceae* might be varieties of the same species. E. F. Smith (1920) says "Potter's white rot of turnip is due to this organism (*B. carotovorus*) and his paper appeared in 1899 (two years earlier than Jones' (L. R.) paper) but he described as its cause a polar flagellate organism and his name therefore cannot be substituted." S. G. Jones (1922) described a polar flagellate organism as causing a white rot of turnip, carrot, radish and cabbage in Wales. Wormald and Harris (1925) isolating from rotting turnips in England obtained only peritrichiate organisms which in fermentation reactions and other tests was indistinguishable from *Bacillus carotovorus* Jones.

Symptoms: This is a wound disease characterized by a soft, watery, grayish white rot of the root. The first signs of the disease are a yellowing, drooping and shriveling of the older leaves. Soon the next leaves above show the same symptoms of premature decay until finally the young leaves at the growing point collapse. The roots of these plants show the characteristic decay. The cells separate from each other along the middle lamella and the tissues become completely disorganized. "White rot."

Hosts: *Brassica rapa, Daucus carota, Solanum tuberosum.*

Geographical distribution: Wales, England, Germany, Japan, Korea.

Control: Care should be taken to prevent all wounds through which the organism may enter the host. See control under *B. carotovorus*.

Literature:

1899. Potter, M. C. On a bacterial disease—white rot—of the turnip. Proc. Univ. of Durham Philosophical Soc., pp. 165–167, Nov., 1899 (abstr. of paper read Dec. 8, 1898). *Pseudomonas destructans* n. sp.

1900. Potter, M. C. On white rot—a bacterial disease—of the turnip. British Assoc. Adv. Sci. Report for 1899: 921–922, 1900.

1901. Carruthers, W., and A. L. Smith. A disease in turnips caused by bacteria. Journ. Bot. **39**: 33–36, 1901.

1901. Potter, M. C. On a bacterial disease of the turnip (*Brassica napus*). Proc. of Royal Soc. London **67**: 442–459, 1901.

1901. Potter, M. C., and M. Foster. Ueber eine Bakterienkrankheit der Rüben (*Brassica napus*). Centralb. f. Bakt. **7**: 282–288, 353–362, 1901.

1902. Potter, M. C. On the parasitism of *Pseudomonas destructans* (Potter). Proc. Roy. Soc. London **70**: 392–397, 1902.

1908. Potter, M. C. On a method of checking parasitic diseases in plants. Journ. Agr. Sci. **3**: 102–107, 1908.

1909. Harding, H. A., and W. J. Morse. The bacterial soft rots of certain vegetables. Part I. The mutual relationships of the causal organisms. New York (Geneva) Agr. Exp. Sta. Tech. Bul. **11**: 255–265, 1909.

1910. Johnson, T., and J. Adams. Bacterial rot in turnips and other brassicas in Ireland. Econ. Proc. Royal Dublin Soc. **2**: 1–7, 1910.

1910. Priestley, J. H., and A. E. Lechmere. A bacterial disease of Swedes. Journ. Agr. Sci. **3**: 390–397, 1910.

1911. Potter, M. C. A brief review of bacteriological research in phytopathology. Science Progress **5**: 191–212, 1911.

1914. Harrison, F. C., and W. Sadler. A bacterial soft rot of turnips. Trans. Roy. Soc. Canada **7** (1913): (Sec. IV) 91–106, 1914.

1914. Harrison, F. C., and W. Sadler. A bacterial soft rot of turnips. 6th Ann. Rept. Quebec Soc. Prot. Plants from Insects and Fungous Diseases 1913–1914: 59–72, 1914.

1914. Ideta, A. Handbook of the plant diseases of Japan. (In Japanese), p. 24, 1914.

1920. Smith, E. F. An introduction to bacterial diseases of plants, p. 223, 1920.

1921. Takimoto, S. Studies on the putrefaction of vegetables (Japanese). Journ. Plant Protection (Tokyo) **8**: 344–353, 1921. Bot. Abstr. **14**: 91–92, 1925. They conclude that the organism isolated from radish corresponds to *Ps. destructans* Potter and that from carrot is similar to *Bacillus carotovorus* Jones, and those from onion and leek are similar to *Bacillus aroideae* Townsend.

1922. Jones, S. G. A bacterial disease of turnip (*Brassica napus*). Journ. Agr. Sci. **12**: 292–305, 1922. Probably varietal form of *Pseudomonas destructans*.

1922. Nakata, K., T. Nakajima, and S. Takimoto. (Studies on sugar beet diseases and their control.) Techn. Rep. Korea Industr. Model Farm 6: 1–118, 1922. (In Japanese.) English abstr. in Japanese Journ. Bot. 1: 43, 1923. White rot (*Bacterium destructans*) is recorded.

1925. Wormald, H., and R. V. Harris. Note on the bacterial soft rot of turnips. Ann. Appl. Biol. 12: 326–329, 1925.

1928. Stapp, C. Schizomycetes (Spaltpilze oder Bakterien) in Sorauer's Handbuch der Pflanzenkrankheiten. 2 (fünfte auflage): 113–115, 1928.

1930. Bergey's Manual of Determinative Bacteriology, p 242, 1930. (3rd ed.)

Bacterium erodii Lewis, 1914

Motile by means of one to three polar flagella; 0.6–0.8 x 1.2–1.8μ; chains; no spores; no capsules; aerobic; Gram negative; not acid fast; beef agar colonies whitish, translucent, glistening, slightly raised, margins entire, with age becoming yellowish and viscid, agar green fluorescent; abundant growth in beef bouillon with delicate ring and medium greened; gelatin liquefied; litmus reduced; ammonia and indol produced; nitrates not reduced; no hydrogen sulphide; grows in Uschinsky's, Fermi's and Cohn's solutions; milk coagulated and cleared; optimum temperature 27°C.; maximum 35°C.; minimum —1°C.; thermal death point 48.5°C.

Synonymy:

Pseudomonas erodii Lewis, 1914.

Phytomonas erodii (Lewis) Bergey et al., 1930.

Symptoms: On *Erodium* spots are circular to elongated angular areas bounded by veins, at first reddish brown, but soon becoming black and watery in appearance. Veins are affected in older stages and the leaves wither and fall. On *Pelargonium* minute pellucid dots appear, soon becoming reddish-brown in the center with a characteristic colorless border. The dead tissue becomes dry and seared producing a typical "frogeye" spot.

Hosts: *Erodium texanum*, *Pelargonium* sp.

Geographical distribution: Connecticut, Pennsylvania, New York, Mississippi, Ohio, Indiana, Illinois, Washington, Texas.

Control: "Under greenhouse conditions the leafspot should be readily controlled by the removal of the diseased leaves, and by careful attention to the method of watering."

Literature:

1912. Heald, F. D., and F. A. Wolf. A plant disease survey in the vicinity of San Antonio, Texas. U. S. Dept. Agric., B. P. I. Bul. 226: 86, 1912. This is the first report of the disease.

1914. Lewis, I. M. A bacterial disease of *Erodium* and *Pelargonium*. Phytopathology 4: 221–231, 1914.

1923. Brown, N. A. Bacterial leafspot of geranium in the eastern United States. Journ. Agr. Res. 23: 361–372, 1923. (See this paper for comparison of *Bacterium erodii* Lewis and *Bacterium pelargoni* Brown.)

1924. Gardner, M. W. Indiana plant diseases 1922. Proc. Indiana Acad. Sci. **33**: 202–211, 1924. *Bact. erodii* on geranium recorded for first time in Indiana.

1930. Bergey's Manual of Determinative Bacteriology, p. 242, 1930. (3rd ed.)

Bacterium (?) fici Cavara, 1905

Motile by four to five flagella (?); 0.5–0.6 x 1.5–2.6μ; chains; capsules; no spores; gelatin is liquefied; milk not coagulated; slight amount of indol produced; nitrates not reduced; yellow on agar; optimum temperature 15°C.; maximum 35–37°C.

Cavara's inoculations were not successful. Petri obtained infections with pure cultures and reisolated the organism. Petri states that the organism is motile and has 4–5 flagella but does not state how they are arranged. Stapp, 1928, says that *Bacterium* (*Bacillus?*) *fici* should probably be considered the cause of the disease.

Symptoms: This organism causes dark spots on the leaves, sudden wilting and drying of the new growth in spring or summer and longitudinal brown spots on the internodes of young branches. These lesions are usually enlarged at the nodes causing scanty growth of leaves. In sections through the branches discolored spots or striations of infected woody tissue appear, yellowish when young and turning brown with age. A yellow slime forms in the bundles.

Host: *Ficus carica.*

Geographical distribution: Italy.

Control: Cutting back infected branches at the earliest possible moment appears to be the only known remedy. Grafting on stocks raised from seed might give resistant trees. Spraying with a 2 per cent Bordeaux mixture at the time the buds are opening, with 0.75 per cent after they have opened, with 1.0 per cent the last of April and with a 1.5 per cent solution in August gave good results.

Literature:

1905. Cavara, F. Bacteriosi del fico. Ist. Bot. della R. Univ. di Catania, Atti, Accad. Gioen. 18, Mem. **14**: 1–18, 1905.

1905. Montemartini, L., and F. Cavara. Bacteriosi del fico (Atti dell' Accademia Gioenia di Catania 1905). Rivista Patologia Vegetale **1**: 10–11, 1905. A review of Cavara's paper.

1906. Petri, L. Ricerche sopra la batteriosi del fico. Atti R. Accad. Naz. Lincei Rend. Cl. Sci. Fis., Mat. e Nat. **15**: 644–651, 1906.

1923. Savastano, L. Delle epidemie italiane del mal secco negli Agrumeti, Albicoccheti, Ficheti, Noceti e Gelseti. Studio di Clinica Arborea. Ann. R. Staz. Sperim. di Agrumic. e Fruttic, Acireale **7**: 134–145, 1923.

1927. Ferraris, T. La batteriosi del fico. Curiamo le Piante! e La Difesa delle Piante contro le Malattie ed i Parassiti. Anno (4 e 22)**5**: 150–151, 1927.

1928. Stapp, C. Schizomycetes (Spaltpilze oder Bakterien). In Sorauer's Handbuch der Pflanzenkrankheiten. **2** (5 fte. aufl.): 84–85, 1928.

Bacterium flaccumfaciens Hedges, 1922

Motile by a single polar flagellum; 0.3–0.5 x 0.6–3.0μ; no chains; no spores; no capsules; aerobic; Gram positive; not acid fast; beef agar colonies round, smooth, wet-shining, flat, semi-opaque, finely granular, entire margins, cream to yellow, viscid; nitrates not reduced; gelatin slowly liquefied; weak diastatic action; no gas; acid from dextrose, lactose, sucrose, glycerin; milk curdled and peptonized; litmus milk reduced; clouding in beef bouillon moderate to strong, sediment viscid; ammonia produced; no indol; no hydrogen sulphide; little if any growth in Cohn's and Fermi's solutions; thin to moderate clouding in Uschinsky's and no rim or pellicle; optimum temperature about 31°C.; maximum 36–40°C.; minimum below 1.5°C.; thermal death point about 60°C.

Synonymy:

Phytomonas flaccumfaciens (Hedges) Bergey et al., 1923.

Pseudomonas flaccumfaciens (Hedges) Stapp, 1928.

Symptoms: This is a vascular disease causing dwarfing, wilting and death of seedlings and a slow wilting, dwarfing and sometimes breaking over of older plants, accompanied by dull green or brownish green discoloration of affected portions which become dry and papery. Pod infection takes place by way of the vascular system and appears as a discoloration along one or both sutures, sometimes spreading laterally. In immature pods diseased areas are yellowish green, somewhat withered and sometimes water-soaked. On mature pods diseased areas are greenish brown while the rest of the pod is yellow. Diseased seed may have a bright yellow bacterial layer under the seed coat or be covered with slime externally or have only a small amount at the hilum. There may be no external signs of infection.

Hosts: (natural) *Phaseolus lunatus macrocarpus, Phaseolus vulgaris;* (artificial) *Soja max.*

Geographical distribution: Maryland, Virginia, Michigan, South Dakota, Montana, Oregon, District of Columbia, France, Germany.

Control: The use of clean seed from wilt-free fields is the best means of control known. The organism may live inside or on the surface of the seed and retain its virulence for at least five years. The use of bean straw as a fertilizer or for fodder should be avoided.

Literature.

1922. Hedges, Florence. A bacterial wilt of the bean caused by *Bacterium flaccumfaciens* nov. sp. Science 55: 433–434, 1922.

1923. Bergey's Manual of Determinative Bacteriology, p. 178, 1923.

1923. Leonard, L. T. An influence of moisture on bean wilt. Jour. Agr. Res. 24: 749–752, 1923.

1924. Hedges, F. Bean wilt (*Bacterium flaccumfaciens* Hedges). Further Studies. Phytopath. 14: 27, 1924. (Abstract.)

1924. Leonard, L. T. Effect of moisture on a seed-borne bean disease. Journ. Agr. Res. 28: 489–497, 1924.

1925. Rands, R. D., and W. Brotherton, Jr. Bean varietal tests for disease resistance. Journ. Agr. Res. 31: 101–154, 1925. 15 varieties were noted which may prove to be resistant to the wilt disease.

1926. Hedges, F. Bacterial wilt of beans (*Bacterium flaccumfaciens*

Hedges) including comparisons with *Bacterium phaseoli*. Phytopathology 16: 1–21, 1926.

1927. Link, G. K. K., and C. G. Sharp. Serological differentiation of *Bacterium campestre* from *Bact. phaseoli*, *Bact. phaseoli sojense* and *Bact. flaccumfaciens*. Phytopath. 17: 53–54, 1927. (Abstract.) These organisms, though closely related are serologically distinct.

1927. Link, G. K. K., and C. G. Sharp. Correlation of host and serological specificity of *Bacterium campestre*, *Bact. flaccumfaciens*, *Bact. phaseoli* and *Bact. phaseoli sojense*. Bot. Gaz. 84: 145–160, 1927.

1927. Sharp, C. G. Virulence, serological and other physiological studies of *Bacterium flaccumfaciens*, *Bact. phaseoli* and *Bact. phaseoli sojense*. Bot. Gaz. 83: 113–144, 1927.

1927. Stapp, C. Die bakterielle Welkekrankheit der Bohnen. Nachrichtenbl. Deutsch. Pflanzensch. 7: 88–90, 1927. The disease probably occurs in Germany and either has escaped notice or been confused with anthracnose.

1928. Hedges, F. Bacterial diseases of beans in some western commercial seed-growing and canning areas and southern trucking sections in 1927 and 1928. U. S. Dept. Agr., B. P. I. Plant Dis. Rep. 12: 121–122, 1928. *Bact. medicaginis phaseolicola*, *Bact. phaseoli*, *Bact. flaccumfaciens*.

1928. Link, Geo. K. K., and A. DeS. Link. Further agglutination tests with bacterial plant pathogens. I. *Bacterium campestre-Bact. phaseoli* group; *Bact. medicaginis* var. *phaseolicola; Bact. tumefaciens*. Bot. Gaz. 85: 178–197, 1928.

1928. Stapp, C. Schizomycetes (Spaltpilze oder Bakterien). In Sorauer's handbuch der Pflanzenkrankheiten. 2 (fünfte auflage): 164–166, 1928.

Bacterium gladioli (Severini) n. comb.

Motile by one or more bipolar flagella; 0.6 x 2.3–2.8μ; no spores; no capsules; Gram negative; aerobic; gelatin liquefied; on all media first yellow—later rust red; gelatin colonies wart like; on agar slants raised, with irregular margins and the medium yellowish red; milk coagulated and slowly peptonized; nitrates not reduced; no indol; no gas; optimum temperature 28°–30°C.; thermal death point 47°C.

Synonymy: *Pseudomonas gladioli* Severini, 1913.

Symptoms: This organism causes a soft rot of gladiolus corms. The leaves begin dying at the tips, the yellowing extending along one or both margins. Gray-black spots appear at the bases of the leaves and in severe cases the plants break over at the base. The aerial parts can be easily pulled from the corm. Yellow or reddish sunken spots develop on the corm which finally becomes flaccid and a yellow brown mass without characteristic odor can be squeezed out. Both old and young corms may be attacked. The bacteria enter the intercellular spaces, destroying the middle lamella and forming cavities.

Hosts: (natural) *Gladiolus colvilli;* (artificial) *Gladiolus segetum*, *Hyacinthus romanus*, *Iris germanica*, *Narcissus tazetta*, *Solanum tuberosum*.

Geographical distribution: Italy, Holland.

Control: Use only healthy corms from localities free from the disease and store them during the resting period in a dry, well ventilated place. Corms, before planting, should be immersed for 15 minutes in water heated to 50°–55°C. This does not injure the corm while the bacteria die at about 47°C.

Literature:

1913. Severini, G. Une bacteriosi dell' *Ixia maculata* e del *Gladiolus colvilli.* Annali di Botanica (Rome) **11:** 413–424, 1913.

1913. Severini, G. Intorno alle attività enzimatiche di due bacteri patogeni per le piante. Annali di Botanica (Rome) **11:** 441–445, 1913.

Bacterium glycines (Nakano) n. comb.

Motile by one polar flagellum; 0.27–0.39 x 1.1–2.15μ; Gram negative; nutrient agar colonies light yellow, convex at center, margin entire; gelatin not liquefied; yellow on gelatin; bouillon clouded with fine granules on surface and walls and yellow precipitate; methylene blue reduced; no gas from sugars; milk cleared without coagulation; no indol.

Synonymy:

Pseudomonas glycines Nakano, 1919.

See *Bacterium glycineum*—symptoms of the two diseases are similar but the two organisms differ in some cultural characters.

Symptoms: This organism causes yellowish circular leaf spots 0.3–0.4 mm. in diameter which gradually change to brown or dark brown and enlarge to 2 mm. in diameter. A heavily infected leaf may have 70–80 spots in a square centimeter. The spots usually remain separate but the leaf turns brown and finally dies.

Host: *Soja max.*

Geographical distribution: Japan.

Literature:

1919. Nakano, K. Daizu no Hayake-byo (n. sp.) (Soybean leaf spot). Journ. Plant Protection (Tokyo) **6:** 39–43, (March) 1919.

1928. Stapp, C. Schizomycetes (Spaltpilze oder Bakterien). In Sorauer's Handbuch der Pflanzenkrankheiten 2(5): 175, 1928.

Bacterium glycineum Coerper, 1919

Motile by one to several polar flagella; 1.2–1.5 x 2.3–3.0μ (Coerper) 0.8–0.9 x 1.2–2.6μ (Wolf); capsules; no spores; Gram negative; not acid fast; aerobic; nutrient agar colonies, white (tinged with brown, Coerper), smooth, glistening, convex, margins entire, butyrous, with or without definite browning of medium; potato agar colonies may show irregular wrinkling or beading in the center; gelatin not liquefied; growth on steamed potato spreading, flat, slimy, more or less viscid, yellowish or grayish white; milk slowly coagulated but no decided separation of curd, and the medium develops a half transparent appearance; litmus milk blued; nitrates not reduced; no gas; acid from dextrose, sucrose, lactose, maltose (only from dextrose and sucrose in the North Carolina strain); slight indol production (Coerper), no indol (Wolf); ammonia produced; good growth in Fermi's and Uschinsky's solutions with fluorescence; slow growth and no fluorescence in Cohn's; no diastatic action; optimum temperature 24°–26°C.; maximum below 35°C.; minimum below 2°C.; thermal death point 48°–

49°C. (Coerper), 43°–48°C. according to hydrogen-ion concentration of medium (Wolf).

Synonymy:

Pseudomonas glycineum Coerper, 1919.

Bacterium sojae Wolf, 1920, (The name *Bacterium soya* Seito was published in 1907. The spellings Soya and Soja are interchangeable. See Bergey 1925).

Phytomonas glycinea (Coerper) Burkholder, 1926.

Phytomonas sojae (Wolf) Burkholder, 1926.

Pseudomonas sojae (Wolf) Stapp, 1928.

See *Bacterium glycines* (Nakano).

Symptoms: Lesions first appear on the cotyledons, usually at the margins. These enlarge, turn brown, the tissue collapses and the seedling may be killed. The infection spreads to the leaves as small, angular, translucent, water-soaked spots, yellow or light brown in color, one to two mm. in diameter which on fusing may form irregular lesions involving considerable portions of the leaf. As they grow older the lesions become dark reddish brown to almost black and the translucency disappears. White drops of exudate collect on the lower surfaces drying to glistening films. There is often a yellowing of the tissue surrounding the lesions. Black lesions of considerable length and breadth occur on stems and petioles.

Lesions on the pods are at first small, water-soaked spots showing drops of exudate. These may increase to involve a large part of the pod, turning dark brown to black with age and the exudate drying down to brownish scales. Seeds become infected and may be covered with slimy bacterial growth.

Host: *Soja max.*

Geographical distribution: Connecticut, Pennsylvania, Indiana, Illinois, Wisconsin, Michigan, North Carolina, South Carolina, Nebraska, Mississippi, Louisiana, Leningrad Russia, Urga Mongolia.

Control: The development of resistant varieties promises the best means of control. Only seed from disease-free pods should be planted.

Literature:

1906. 19th Ann. Rept. Nebraska Agr. Exp. Sta. for 1905: 71, 1906.

1906. Heald, F. D. New and little-known plant diseases in Nebraska. Science **23**: 624, 1906. One of the first reports of bacterial blight of soy bean.

1907. Saito, K. Mikrobiologische Studien über die Soyabereitung. Centralb. f. Bacteriol. **17**: 20–27, 1907. *Bacterium soya* Saito.

1911. Smith, E. F. Bacteria in relation to plant diseases **2**: 69, 1911. He reports a bacterial leaf spot of soy bean.

1916. Clinton, G. P. Notes on plant diseases of Connecticut. Connecticut Agr. Exp. Sta. Rept. 1915: 444–446, 1916. He reports a bacterial leafspot of soy bean like the one described by Heald in Nebraska.

1917. Johnson, A. G., and F. M. Coerper. A bacterial blight of soy bean. Phytopath. **7**: 65, 1917. (Abstract.)

1918. Tisdale, W. H. Report of the division of plant pathology and bacteriology. Ann. Rpt. North Carolina Agr. Exp. Sta. **41** (1917–18): 59, 1918.

1919. Coerper, F. M. Bacterial blight of soybean. Journ. Agr. Res. **18**: 179–194, Nov., pub. Dec. 18, 1919.

1920. Wolf, F. A. Bacterial blight of soybean. Phytopath. **10**: 119–132, 1920.

1920. Woodworth, C. M., and F. C. Brown. Studies on varietal resistance and susceptibility to bacterial blight of the soy bean. Phytopath. **10**: 68, 1920. Of 47 varieties tested about half were completely resistant and the other half ranged from complete susceptibility to partial resistance.

1921. Kendrick, J. B., and M. W. Gardner. Seed transmission of soybean bacterial blight. Phytopath. **11**: 340–342, 1921. They show that bacterial blight of soy bean is transmitted with seed from diseased pods. The organism used "closely resembles the non-pigment-producing strain No. 211 of *Bact. glycineum* which is considered by Shunk and Wolf as identical with *Bact. sojae*."

1921. Shunk, I. V., and F. A. Wolf. Further studies on bacterial blight of soybean. Phytopath. **11**: 18–24, 1921. They found that the diseases due to *Bacterium glycineum* and *Bacterium sojae* could not be differentiated with certainty in the field and that *Bacterium sojae* was identical with the non-pigment forming strain of *Bacterium glycineum.*

1921. Shunk, I. V., and F. A. Wolf. Soybean bacterial blight. Phytopath. **11**: 52, 1921. (Abstract.)

1921. Wolf, F. A., and A. C. Foster. Studies on the physiology of some plant pathogenic bacteria. North Carolina Agric. Exp. Sta. Tech. Bul. 20: 1921. IV. Thermal death points of some bacterial plant pathogenes in relation to reaction of the medium, pp. 21–24. V. The fermentative activity of some plant pathogenic bacteria in relation to hydrogen-ion concentration, pp. 25–43, 1921.

1921. Wolf, F. A., and I. V. Shunk. Tolerance to acids of certain bacterial plant pathogenes. Phytopath. **11**: 244–250, 1921.

1922. Wolf, F. A. Studies on fermentation of rare sugars by plant pathogenic bacteria. Journ. Elisha Mitchell Sci. Soc. **38**: 12–13, 1922. *Bacterium glycineum* attacks mannitol and galactose. *Bacterium sojae* does not.

1923. Wolf, F. A. Studies on the physiology of some plant pathogenic bacteria; VII Pectic fermentation in culture media containing pectin. Phytopath. **13**: 381–384, 1923.

1924. Gardner, M. W. Indiana Plant Diseases, 1921. Proc. Indiana Acad. Sci. **33**: 189, 1924. "The causal organism has been studied in culture and found to be the non-chromogenic strain of *Bact. glycineum.*"

1924. Wolf, F. A. Bacterial pustule of soybean. Journ. Agr. Res. **29**: 57–68, 1924. The author mentions *Pseudomonas glycineum* Nakano and later says "It remains for subsequent investigation to determine the identity of the organism of Takimoto (unnamed) and *Bacterium sojae* and whether either or both are identical with *Pseudomonas glycineum* Nakano." In a footnote he states that he has not seen Nakano's original paper.

1925. Bergey's Manual of Determinative Bacteriology, p. 183, 1925. (2nd ed.)
1925. Burgwitz, G. K. (Bacterial blight and spotting of soy-bean [*Glycine hispida* Maxim.].) Bolezni Rost. Leningrad, **14**: 38–41, 1925. (In Russian with German summary.) Soybean seedlings raised at the Chief Botanic Garden in Leningrad, from seed received from Mongolia, and on soil never before planted to soy beans, developed a spotting of the leaves which spread all over the plants and was found to be due to *Bacterium glycineum.* It must have been introduced on the seed from Mongolia where it had not been reported to occur.
1926. Burkholder, W. H. A new bacterial disease of bean. Phytopath. **16**: 922, 1926.
1928. Stapp, C. Schizomycetes (Spaltpilze oder Bakterien). In Sorauer's Handbuch der Pflanzenkrankheiten 2 (fünfte auflage): 174, 1928.

Bacterium glycineum var. japonicum (Takimoto) n. comb.

Motile by one to four polar flagella; 0.6–0.8 x 1.6–3.0μ; no spores; capsules; Gram negative; aerobic; agar colonies white, smooth, round, glistening, with undulate margins, and no change in color of the medium; gelatin not liquefied; litmus milk blued, but not reduced; nitrates not reduced; no indol; no gas; acid from sucrose and dextrose; optimum temperature 25°–27°C.; maximum 37°C.; minimum 3°C.; thermal death point 47°C.

Synonymy: *Bacterium soyae* var. *japonicum* Takimoto, 1927.

Symptoms: Small, yellowish, water-soaked, round or angular spots appear on the under surfaces of the leaves. These increase in size becoming blackish brown in the center and changing to light brown as the spot grows, the margin becoming darker brown. There is sometimes no yellow stage. Tissue about the spots may turn yellow. There may be 30–40 or more spots on a leaf. Infections may also occur on the veins which become dark blackish brown. Elliptical or irregularly linear spots may occur on the petioles. Spots on the pods are brown to blackish and sunken.

Hosts: *Soja max, Phaseolus angularis, Phaseolus* sp.

Geographical distribution: Japan.

Control: See *Bacterium glycineum.*

Literature:

1921. Takimoto, S. Daidzu no saikinsei hantenbyo (Bacterial spotting disease of soybean). Byochu gai zasshi. (Journal Plant Protection (Tokyo) **8**: 237–241, 1921.
1927. Takimoto, S. (A bacterial spot disease of soy bean.) Journal Plant Protection (Tokyo) **14**: 559–566, 1927.

Bacterium gummisudans McCulloch, 1924

Motile by one polar flagellum; 0.6–0.8 x 1.0–2.8μ; capsules; no spores; aerobic; Gram negative; not acid fast; agar colonies pale yellow, viscid, circular, transparent, smooth; moderate clouding in beef bouillon with a thick yellow rim and

a thin pellicle; gelatin slowly liquefied; blood serum partly liquefied; growth on potato cylinders pale yellow and abundant; milk curdled and rapidly digested and heavy, yellow, viscid rims formed; litmus milk slowly reduced; no gas; acid from dextrose and saccharose; growth scanty in Cohn's, Uschinsky's and Fermi's solutions; ammonia and hydrogen sulphide produced; no indol; nitrates not reduced; optimum temperature about 30°C.; minimum below 2°C.; maximum 36°C.; thermal death point near 50°C.; sensitive to sodium chloride and acids; readily killed by drying and sunlight.

Synonymy: *Phytomonas gummisudans* (McCulloch) Bergey et al., 1925.

Symptoms: This organism causes narrow, horizontal, water-soaked, dark green spots which later become brown, more or less regular, squares or rectangles. These may involve the entire leaf, especially in young stock but often occur only on the middle area of the leaf. The translucency is permanent. Exudate forms slender, twisted white columns or a viscid film in which soil, insects and other particles become embedded. The development of the corm is impeded. The organism enters through the stomata invading the parenchyma and filling the intercellular spaces and cavities due to the destruction of cell walls.

Host: *Gladiolus* sp.

Geographical distribution: Indiana, Michigan, Minnesota, North Dakota, Ohio, Ontario, Canada.

Control: Field observations and inoculations showed that the variety Schwaben is susceptible, Mrs. Francis King resistant, and Mrs. Frank Pendleton immune. Nelson (1927) reports that soaking corms just before planting in a 1–120 formalin solution for two hours or a 0.5–1.0 per cent Semesan or Uspulun solution is effective in controlling the disease.

Literature:

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Bacterium hibisci Nakata and Takimoto, 1923

Motile by one to two polar flagella; 0.6–0.7 x 1.2–2.0μ; chains; no capsules; no spores; Gram negative; aerobic; agar colonies smooth, round, slightly raised,

color of cement; gelatin liquefied; milk slowly peptonized; no gas; nitrates slightly reduced; no indol; thermal death point 49°C.

Synonymy:

Pseudomonas hibisci (Nakata and Takimoto) Stapp, 1928.

Phytomonas hibisci (Nakata and Takimoto) Bergey et al., 1930.

Symptoms: This disease first appears as small circular black spots on cotyledons and young leaves. These enlarge gradually to irregular angular spots with dull white to yellow outer zones, which may have a water-soaked appearance. When leaves are severely attacked the whole plant becomes blackened and withered.

Host: *Hibiscus* sp.

Geographical distribution: Japan, Korea.

Control: The disease is transmitted on the seed and can be controlled by seed treatment with mercuric chloride 1–1,000 or hot water (55°C.) for ten minutes. Spraying with 5–5–50 Bordeaux mixture greatly reduces infection.

Literature:

1923. Nakata, N., and K. Takimoto. Bacterial blight of hibiscus. Ann. Phytopath. Soc. Japan 1: 13–19, 1923. (In Japanese with English summary.)

1928. Stapp, C. Schizomycetes (Spaltpilze oder Bakterien). Sorauer's Handbuch der Pflanzenkrankheiten, 2 (fünfte auflage): 203, 1928.

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Bacterium holci Kendrick, 1926

Motile by one to four polar flagella; 0.6–1.0 x 1.5–2.9μ; no spores; no capsules; Gram negative; aerobic; nutrient agar colonies round, smooth, glistening, raised or pulvinate, margin entire, grayish white, viscid, slightly greenish fluorescent by transmitted light; growth on potato cylinders moderate, grayish white, smooth, glistening, medium slightly grayed; greenish pigment produced in Fermi's and Uschinsky's solutions; no growth in Cohn's; gelatin liquefied; milk cleared without coagulation; nitrates reduced; no indol; no gas; acid from arabinose, dextrose, galactose, mannose, sucrose, xylose; no diastatic action; optimum temperature 25°–30°C.; maximum 35°C.; minimum 0°C.; thermal death point 49°C.

Synonymy:

Pseudomonas holci Kendrick, 1926.

Phytomonas holci (Kendrick) Bergey et al., 1930.

Symptoms: This is a spot disease of sorghum, Johnson grass, millet, corn and foxtail, characterized by round, oblong linear to irregular red or brown leaf lesions of varying size. On sorghum, sudan grass and Johnson grass spots are red or light centered with a red border. On foxtail and pearl millet lesions are dark brown in color with light greenish halos. Necrotic marginal infections are more common than on the other hosts. Spots on corn occur only on the leaves and are more numerous toward the tips. They are at first dark green, water-soaked, round, elliptical to linear or irregular and 2–10 millimeters in diameter. Later they lose their water-soaked appearance and become brown centered with darker brown to reddish brown narrow borders. By transmitted light a yellowish

halo is visible. Long necrotic marginal lesions develop along the margins of lower leaves. The bacteria are at first intercellular but later become intracellular.

Hosts: *Chaetochloa lutescens, Holcus halepensis, Holcus sorghum* (22 varieties), *Holcus sorghum sudanensis, Holcus sorghum technicus, Pennisetum glaucum, Zea mays* (20 varieties).

Geographical distribution: Iowa.

Control: The following are recommended: Clean cultivation, destruction of self-sown plants of susceptible species of *Holcus* growing in or near maize fields, the selection of sorghum seed from fields free from the disease and crop rotation, since the organism lives over in the soil.

Literature:

1926. Kendrick, J. B. *Holcus* bacterial spot on species of *Holcus* and *Zea mays*. Phytopathology **16**: 236–237, 1926.

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Bacterium hyacinthi Wakker, 1883

Motile by one polar flagellum; 0.4–0.6 x 0.8–2.0μ; chains; no spores; Gram negative; aerobic; growth on agar flat, smooth, glistening, bright yellow; growth on sugar agars dry and wrinkled or shagreened; gelatin and blood serum slowly liquefied; acid from dextrose, sucrose, levulose; milk coagulated and partially peptonized; diastatic action feeble; feeble growth in Uschinsky's solution; hydrogen sulphide produced; litmus slowly reduced; indol sparingly produced; nitrates not reduced; optimum temperature 28°–30°C.; maximum 35°C.; minimum 4°C.; thermal death point 47.5°C.

Synonymy:

Bacillus hyacinthi (Wakker) Trevisan, 1889.

Pseudomonas hyacinthi (Wakker) E. F. Smith, 1897.

Phytomonas hyacinthi (Wakker) Bergey et al., 1923.

Symptoms: Water-soaked stripes appear beginning toward the tip of the leaf. These soon turn brown, die and dry out leaving a dead brown stripe extending a part or the whole length of the leaf. Infected flower stalks may or may not show a water-soaked appearance followed by browning and shriveling. In infected bulbs the vascular bundles are bright yellow and full of bacterial slime. This infection may spread down into the base of the bulb and out into the bundles of other scales and into the parenchyma until the bulb is finally destroyed. In late stages of the disease small pockets form in the scales. The disease progresses slowly either from the leaves into the bulb or from the bulb out into the leaves. Infection on one side of a bulb may result in dwarfing and one sided growth of foliage. Wakker's yellow disease of hyacinth.

Host: *Hyacinthus orientalis*.

Geographical distribution: Holland, Denmark, Germany, France, Italy, Great Britain, Japan, Washington, U. S. A.

Control: Diseased bulbs should be removed from the field as soon as found and destroyed. Knives used in cutting operations should be disinfected. Excellent control has been obtained by exposure of bulbs during August to a temperature of 28° to 30°C. in order to separate diseased from healthy bulbs and to a temperature of 34°–47.5° through September as these are the maximum temperature and thermal death point for *Pseudomonas hyacinthi*. Immersion of bulbs in water at 47.5°C. or above has also given promising results. Ferraris (1928) recommends removal of dry outer scales, soaking in a 10–15 per cent solution of iron sulphate and drying in the air before planting. Dormant bulbs should be stored under dry well aerated conditions. Some varieties are more resistant than others to the disease.

Literature:

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Bacterium intybi (Swingle) n. comb.

Polar flagella; rods; no spores; Gram negative; no indol; no diastatic action; gelatin liquefied; gas; nitrates reduced; thermal death point 51°C.

Synonymy: *Phytomonas intybi* Swingle, 1925.

Symptoms: This organism causes a center rot of a yellowish olive color which affects chiefly the young inner leaves.

Host: *Cichorium intybus.*

Geographical distribution: Montana.

Literature:

1925. Swingle, D. B. Center rot of "French Endive" or wilt of chicory (*Cichorium intybus* L.). Phytopathology 15: 730, 1925. (Abstract.)

Bacterium iridis (van Hall) n. comb.

Motile by one polar flagellum; 0.8 x 0.9–1.5μ; no spores; no chains; facultative anaerobe; Gram negative; gelatin not liquefied; nitrates not reduced; no diastatic action; indol and hydrogen sulphide produced; gas from glucose, sucrose, maltose; acid from glucose and sucrose; gray-green on gelatin; optimum temperature about 30°C.; thermal death point 53°–54°C.

Synonymy: *Pseudomonas iridis* van Hall, 1902.

Symptoms: This organism causes yellowing and wilting of leaves and soft rot of shoots and bulbs of iris. Young shoots lag behind others in growth, leaves begin to yellow and soon dry out at the top and the whole iris shoot dies off in a short time. The base of the blade and the one-year-old part of the root stalk have become a soft, watery, yellow to brown colored mass without a bad odor. Sometimes the whole clump dies and nothing of the underground parts remains but a soft white mush surrounded by the intact corky layer of the root stalk.

Hosts: *Iris florentina, Iris germanica.*

Geographical distribution: Great Britain, Holland, France.

Control: See *Bacillus carotovorus.*

Literature:

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Bacterium jaggeri (Stapp) n. comb.

Motile by one to three polar flagella; 0.44–0.87 x 0.87–1.74μ; growth in nutrient agar rapid, grayish white, glistening, circular, margins entire, flat to slightly raised, medium usually greened; gelatin liquefied; milk cleared without coagulation; heavy clouding in nutrient broth and no surface growth; no gas; acid from glucose and sucrose; nitrates not reduced; growth on potato cylinders abun-

dant, grayish to yellowish white; no diastatic action; no growth in Cohn's and Uschinsky's solutions.

Synonymy:

Pseudomonas apii Jagger, 1921.

Phytomonas apii (Jagger) Bergey et al., 1923.

Pseudomonas jaggeri Stapp, 1928. (The names *Bacterium apii* Brizi and *Bacillus apii* (Brizi) Migula have already been used in literature.)

Symptoms: This organism causes small, irregularly circular, rusty brown spots rarely exceeding 5 mm. on the leaf blades. Spots seldom occur on the petioles. Occasionally spots are so numerous as to cause the death of older leaves but usually they only disfigure the foliage.

Host: *Apium graveolens.*

Geographical distribution: Delaware, Ohio, Florida, New York, Indiana, Michigan, Minnesota.

Control: The disease may be controlled by spraying with Bordeaux mixture 5–5–50 or copper lime (15–85) at intervals of 7–10 days after the infection starts. Lime sulphur is not effective. Dusting seedlings 2–4 times with 20–80 copper-lime dust at weekly intervals before transplanting gives marked reduction throughout the season.

Literature:

1914. Jagger, I. C. A bacterial leaf spot disease of celery. Phytopath. **4**: 395, 1914. (Abstract.)

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Bacterium juglandis (Pierce) E. F. Smith, 1905

Motile by one polar flagellum; 0.3–0.5 x 1.5–3.0μ; no spores; chains; no capsules; Gram positive; aerobic; nutrient agar colonies at first white becoming straw yellow to lemon yellow, round, moist, glistening, deeper yellow at the

center, margins regular to slightly undulate; acid from galactose; no gas; gelatin slowly liquefied; growth on potato abundant, moist, glistening, pale lemon yellow, raised, viscid, with a white band just beyond the margin; good growth in beef bouillon with ring but no pellicle; diastatic action present; no growth in Cohn's solution; milk coagulated and peptonized; indol produced; nitrates not reduced.

Synonymy:

Pseudomonas juglandis Pierce, 1901.

Phytomonas juglandis (Pierce) Bergey et al., 1930.

Symptoms: Leaf lesions occur chiefly on the veins and petioles which turn brown or black. Circular to angular spots also occur in the parenchyma and may fuse to form large brown areas. Twig lesions are at first small, water-soaked spots which may increase to several inches in length. The central portion turns black and is surrounded by a water-soaked margin. Infected twigs die back from the tip and if sufficiently blighted, may dwarf the tree. As the twig becomes woody the disease is checked. Infection may extend only to bark and wood or may penetrate to the pith. Catkins may become wholly or only partly blackened. The disease is most serious and destructive on young nuts many of which fall when $\frac{1}{8}$–$\frac{1}{2}$ inch in diameter. Nuts may become infected at the time of pollination, the infection spreading from the blossom end until the nut falls or the kernel is reached and blackened, or secondary infections may start at any point on the surface of the nut as small circular water-soaked spots which increase rapidly in size to sunken black areas with water-soaked margins. These lesions may penetrate the shell and deform and blacken the kernel. Late infections of nuts are usually shallow and superficial. At the borders of lesions on branches and nuts masses of whitish exudate are abundant. Walnut blight, bacteriosis, California walnut bacteriosis.

Hosts: *Juglans californica, Juglans cinerea, Juglans hindsii, Juglans nigra, Juglans regia, Juglans sieboldiana, Juglans sieboldiana cordiformis.*

Geographical distribution: The disease occurs in the Pacific Coast States and is more or less general throughout the eastern walnut growing districts of the United States; Mexico, Chile, South Africa, New Zealand, Tasmania, Australia, Russia, Italy, France, Switzerland.

Control: Infected trees should be carefully pruned and diseased twigs and nuts burned. Spraying the trees while still dormant with a lime sulphur solution (5 gallons of commercial lime sulphur to 95 gallons of water) is said to reduce the amount of blight. The most promising means of control appears to lie in the development of resistant varieties or in grafting susceptible commercial varieties on immune stock. *Juglans nigra* and the native black walnut of California, *Juglans hindsii*, are being used for such stock.

Literature:

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1915. Barss, H. P. A new filbert disease in Oregon. A preliminary report. Second Biennial Crop Pest and Horticultural Report. Oregon Agr. College Exp. Sta. 1913–1914: 213–223, 1915.

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1922. Smith, C. O. Some studies relating to infection of and resistance to walnut blight, *Pseudomonas juglandis*. Phytopath. 12: 106, 1922. (Abstract.)

1923. Savastano, L. Delle epideme italiane del mal secco negli Agrumeti Albicoccheti, Ficheti, Noceti e Gelseti. Studio di Clinica Arborea. Ann. R. Staz. Sperim. di Agrumic. e Fruttic. Acireale 7: 146–150, 1923. Experiments with *Juglans nigra* as a resistant stock gave satisfactory results.

1923. Walnut-blight. Introduction of immune variety by the Department. New Zealand Journ. Agric. 27: 25, 1923. The only hope of controlling the disease appears to lie in grafting susceptible commercial varieties on immune stocks. In California the native black walnut (*Juglans hindsii*) is used for such stock and is being introduced into New Zealand.

1924. Barss, H. P. Filbert blight. Ann. Rep. West. Nut Grow. Assoc. 6: 29, 1924.

1924. Müller-Thurgau, H., and A. Osterwalder. Bericht der Schweizerischen versuchsanstalt für Obst-Wein-und Gartenbau in Wädenswil für die Jahre 1921–1923. III. 1. Pflanzenphysiologische und

pflanzenpathologische Abteilung. Landw. Jahrb. der Schweiz. 38: 573–574, 1924. *Pseudomonas juglandis* reported on walnut in Switzerland.

1926. Ferraris, T. Trattato di Patologia e Terapia Vegetale 3rd ed., 121, 1926.

1926. Anonymous. Black spot on walnuts. Garden and Field (Australia) 51(1): 13, 1926. *Bact. juglandis* is reported from the Mount Lofty Ranges and in the Auburn district of Australia.

1927. Archer, W. A. Diseases of fruit and nut crops in the United States in 1926. U. S. Dept. Agric., B. P. I., Plant Disease Reporter. Sup. 52: 107, 1927. *Bact. juglandis* on *Juglans regia* occurred in an epidemic form in California causing a loss of 60 per cent.

1928. Stapp, C. Schizomycetes (Spaltpilze oder Bakterien) in Sorauer's Handbuch der Pflanzenkrankheiten 2 (fünfte auflage): 74–77, 1928.

1930. Bergey's Manual of Determinative Bacteriology, p. 240, 1930. (3rd. ed.)

Bacterium (?) krameriani Pavarino, 1911

No plates having been poured, there is no certainty that he was working with pure cultures. He states that he reproduced the disease by sub-epidermal inoculation. 2.0–3.0 x 0.6–0.8μ; spore-forming; Gram negative; greenish on agar; gelatin liquefied; aerobic.

Synonymy: See *Bacterium cattleyae.*

Symptoms: This organism is said to cause small rusty spots on the leaves, visible at first only by transmitted light but increasing in size, becoming irregular in shape and darker in color and extending to the pseudo-bulbs which become brown, shrivel and dry out.

Host: *Oncidium kramerianum.*

Geographical distribution: Pavia, Italy.

Literature:

1911. Pavarino, G. L. Malattie causate da bacteri nelle Orchidee. Nota preliminare. Atti R. Accad. Naz. Lincei Rend. Cl. Sci. Fis., Mat. e Nat. 20: 233–237, 1911.

1918. Pavarino, G. L. Alcune malattie delle Orchidee causate da bacteri. Atti dell Istituto Botanico R. Univ. Pavia. 15: 81–86, 1918 (same paper as 1911).

Bacterium lachrymans Smith and Bryan, Dec., 1915

Motile by one to five polar flagella; 0.8 x 1.0–2.0μ; chains; no spores; capsules; Gram negative; not acid fast; aerobic; nutrient agar colonies round, smooth, glistening, slightly convex, with opaque white center and thin, transparent, entire margin; gelatin slowly liquefied; growth in beef bouillon weak to moderate, with membranous pellicle, becoming green fluorescent with age; partial digestion of starch; milk cleared without coagulation; litmus in milk reduced; no gas; acid from dextrose and sucrose; nitrates not reduced; growth in Uschinsky's solution heavy, with heavy pellicle and medium becomes pale apple green; Fermi's solution becomes green fluorescent; good clouding in Cohn's solution

without pellicle or greening; small amount of indol produced; no hydrogen sulphide; methylene blue rapidly reduced; optimum temperature 25°–27°C.; maximum 35°C.; minimum 1°C.; thermal death point 49°–50°C.

Synonymy:

Bacillus burgeri Potebnia, Nov., 1915.

Phytomonas lachrymans (Smith and Bryan) Bergey et al., 1923.

Pseudomonas lachrymans (Burger) Ferraris, 1926.

(Potebnia named the organism from Burger's description. Potebnia's publication is dated August, 1915, but was not issued until November, 1915 according to a statement by the Society of Cultural Relations with Foreign Countries, Moscow, Russia, August 9, 1927. Potebnia's name is therefore earlier than that of Smith and Bryan, but since it is put in the genus *Bacillus* and described as peritrichiate, white becoming yellowish with age, coagulating milk, and not liquefying gelatin, this name is not retained.)

Symptoms: The disease first appears as round to irregular, water-soaked spots on the cotyledons and on later leaves as angular water-soaked brown spots which dry and may fall out, leaving ragged leaf tissue. Water-soaked spots covered with white exudate also occur on stems and petioles. Spots on the fruit are at first minute, circular, water-soaked areas which later develop chalky white centers due to drying and cracking of the tissues. These spots afford entrance to secondary rot-producing organisms.

Hosts: *Bryonopsis laciniosa*, *Cucumis anguria*, *Cucumis dipsaceus*, *Cucumis sativus*, *Lagenaria leucantha* (*vulgaris*), *Luffa acutangula* (*Cucumis acutangulus*).

Geographical distribution: The disease is widely distributed in United States, Canada and Europe.

Control: The organism overwinters on the seed. Two-year-old seed may carry the disease, but three-year-old seed does not. The most effective method of control is by seed disinfection in 1:1,000 mercuric chloride for 5–10 minutes and then washing thoroughly and drying. Spraying with 4–4–50 Bordeaux mixture or dusting with copper-lime dust (80–20 formula) are of considerable importance in controlling the disease after it appears in the field.

Literature:

1913. Burger, O. F. A new cucumber disease. Florida Agr. Exp. Sta., Ann. Rpt. 1911–12: C–CI, 1913.

1913. Burger, O. F. A bacterial rot of cucumbers. Phytopath. 3: 169–170, 1913. He describes the disease and the organism but does not name it. He says here that the organism has 3–6 polar flagella.

1914. Burger, O. F. Bacterial rot of cucumbers. Florida Agr. Exp. Sta., Ann. Rpt. for 1912–1913: 90–94, 1914. No organism named.

1914. Burger, O. F. Cucumber rot. Florida Agr. Exp. Sta. Bul. 121: 97–109, 1914. No organism named but he says here that the flagella are peritrichiate.

1915. Potebnia, A. A. Gribnye Parasity Vysshikh Rastenii Kharkovsk i Smezhnykh Guberni Khorkav Obl. Selskokh. Opyt. Sta., No. 1, Str. 37–42, ris. 1–19, 1915. (Fungous parasites of the higher plants in Kharkov and adjacent provinces. Kharkov Prov. Agr. Exp. Sta., No. 1: 37–42, 1915 (August). Reviewed by

M. Shapovalov in Phytopath. 6: 293–295, 1916. (See also Exp. Sta. Rec. 35: 454, 1916.)

1915. Smith, E. F., and M. K. Bryan. Angular leafspot of cucumbers. Journ. Agric. Res. 5: 465–475, Dec. 15, 1915. *Bacterium lachrymans* n. sp.

1915. Traverso, G. B. Sulla bacteriosi del cetriolo in Italia. Nota preliminare. Atti R. Accad. Naz. Lincei, Rend. Cl. Sci. Fis., Mat. e. Nat., 24: (sem. 1), 456–460, 1915.

1916. Carsner, Eubanks. Angular leafspot, a bacterial disease of cucumbers. Phytopath. 6: 105–106, 1916. (Abstract.)

1917. Carsner, E. Do the bacteria of angular leafspot of cucumber overwinter on the seed? (Abstract.) Phytopath. 7: 61–62, 1917.

1917. Faulwetter, R. C. Dissemination of the angular leafspot of cotton. Journ. Agr. Res. 8: 457–475, 1917.

1918. Carsner, E. Angular leafspot of cucumber: dissemination, overwintering, and control. Journ. Agr. Res. 15: 201–220, 1918.

1918. Gardner, M. W., and W. W. Gilbert. Cucumber angular leafspot and anthracnose overwintering and seed treatment control. Phytopath. 8: 79–80, 1918.

1918. Gilbert, W. W., and M. W. Gardner. Seed treatment, control and overwintering of cucumber angular leafspot. Phytopath. 8: 229–233, 1918.

1921. Gardner, M. W., and W. W. Gilbert. Field tests with cucumber angular leafspot and anthracnose. Phytopath. 11: 298–299, 1921. They obtained evidence that the organism does not overwinter in the soil.

1921. Jones, L. R., and S. P. Doolittle. Angular leafspot of cucumber. Phytopath. 11: 297–298, 1921.

1922. Meier, F. C., and G. K. K. Link. Bacterial spot of cucumbers. U. S. Dept. Agr., Dept. Circ. 234: 5 pp., 1922.

1923. Bergey's Manual of Determinative Bacteriology, p. 184, 1923.

1924. Burgwitz, G. K. Bakterielle Blattfleckkrankheit der Gurken. Bolezn. Rast. (Morbi plantarum) 13: 50–51, 1924. (All in Russian.) *Bacillus burgeri* A. Pot.

1925. Brookes, R. St. John, K. Nain and M. Rhodes. The investigation of phytopathogenic bacteria by serological and biochemical methods. Journ. Path. and Bakt. 28: 203–209, 1925. See *Bacillus carotovorus*.

1925. Weber, G. F. Diseases of cucumbers. Florida Agr. Exp. Sta. Bul. 177: 41–46, 1925.

1926. Ferraris, T. Trattato di Patologia e Terapia vegetale 1: 132–133, 1926. *Pseudomonas (Bacterium) lachrymans* Burger.

1928. Weber, Geo. F. Cucumber fruit-rot and angular leafspot. Phytopath. 18: 133, 1928. Angular leafspot in the field in Florida may or may not be accompanied by fruit rot and fruit rot is always accompanied by angular leafspot. The same organism causing both symptoms.

1928. Gilbert, W. W. Control of cucumber and cantaloupe diseases in Maryland. Rpt. Maryland Agr. Soc. and Maryland Farm Bureau Federation 12 (1927): 403, 1928.

1929. Riker, A. J. Studies on the influence of environment on infection by certain bacterial plant parasites. Phytopath. 19: 96, 1929. (Abstract.)

Bacterium leguminiperdum (von Oven) Stevens, 1913

Motile by polar flagella; 0.8 x 2.0–2.3μ; spores; Gram negative; aerobic and facultative anaerobic; gelatin colonies white, round; agar colonies shiny gray; no indol; no hydrogen sulphide; gelatin liquefied; no fermentations in sugar gelatin.

Synonymy: *Bacillus leguminiperdus* v. Oven, 1906.

Von Oven says the organism is motile by means of polar flagella.

Symptoms: This organism causes small, sunken water-soaked spots on the pods which fuse into large brown areas finally involving the whole outer surface of the pod. The infected pods are small and ripen prematurely and the seeds are small and shriveled. His inoculations indicate that the organism may destroy germinating peas and seedlings and that stems also may contract the disease. The organism is believed to enter through the stomata. In early stages of the disease on beans infected portions are bordered by narrow red brown margins and a sticky yellowish green secretion oozes out of the spots.

Hosts: *Lupinus* sp., *Lycopersicum esculentum*, *Phaseolus vulgaris*, *Pisum sativum.*

Geographical distribution: Vicinity of Berlin, Germany.

Control: von Oven's observations lead him to believe infections are more abundant on some varieties of peas than others and are particularly numerous when the vines lie flat on the ground. He recommends maintaining an upright growth by sowing peas along with rye.

Literature:

1906. v. Oven, E. Eine neue bakterienerkrankung der leguminosenfruchte. Centralb. f. Bakt. 16: 67–74, 1906.

1913. Stevens, F. L. The fungi which cause plant disease, p. 28, 1913.

Bacterium levistici (Osterwalder) Stevenson, 1926

Motile by one polar flagellum; 0.5–1.1 x 1.1–1.5μ; no spores; Gram negative; gelatin colonies grey white, margin sinuate, a compact mass that may be lifted as a whole; agar streaks are irregularly lobed, wrinkled, slimy; gelatin liquefied; indol produced; no hydrogen sulphide.

Synonymy: *Pseudomonas levistici* Osterwalder, 1909.

Symptoms: This organism causes small, sunken, brown spots or large, irregular dead areas with yellow margins on the leaf blades. On the petioles and stems long, narrow golden brown to black stripes are formed between the collenchyma ridges. The subepidermal chlorophyll-bearing tissue, several layers thick, as well as the epidermis becomes brown, while the adjoining collenchyma is yellowed and the intercellular spaces are filled with bacteria. The underlying, non-chlorophyll bearing cells with the vascular bundles are always entirely normal

in color and free from bacteria. Often great lacunae filled with bacteria form by the separation of the epidermis from the underlying tissue.

Host: *Levisticum officinale.*

Geographical distribution: Wädenswil, Switzerland.

Literature:

1909. Osterwalder, A. Unbekannte Krankheiten an Kulturpflanzen und deren Ursachen. 1: Die Bakterienkrankheit bei *Levisticum officinale* Kch., verursachte durch *Pseudomonas levistici* nov. spec. Centralb. f. Bakt. 25: 260–265, 1909.

1926. Stevenson, J. A. Foreign Plant Diseases. U. S. Dept. Agric., Office of Secy., 101, 1926.

Bacterium (?) lycopersici Burgwitz, 1924

Plates were not poured and it is not certain that he worked with pure cultures. 0.75–1.5 x 0.5–0.75μ; motile (flagella not demonstrated); single or in pairs; no capsules; no spores; Gram negative; grey-white to slightly yellow; gelatin liquefied; slightly fluorescent on agar; milk coagulated and slightly peptonized; ammonia produced; no H_2S; indol produced; gas formed with glucose, sucrose, maltose, galactose, dextrin, mannit; no gas with glycerin, lactose, levulose; no diastatic action; aerobic; thermal death point 68°C. For status of blossom-end rot see *Bacterium briosii.*

Symptoms: This organism is said to cause dark brown round to oval spots at the blossom end which spread rapidly to involve the free half of the fruit. As the fruit ripens the spots cease to grow, the epidermis becomes sunken and the fruit falls. The rot spreads toward the interior of the fruit where cavities are formed and are soon filled with a dark brown pulpy mass. In some cases the progress of the disease is checked by the formation of a corky layer. Blossom end rot.

Host: *Lycopersicum esculentum.*

Geographical distribution: Leningrad, Russia.

Control: The variety Danish Export proved to be immune. Diseased fruit should be burned. Deep ploughing and crop rotation are advocated. Only seed from healthy plants should be used or seed should be treated for 5 minutes in a 10 per cent solution of formaldehyde or in a 1 to 4,000 solution of corrosive sublimate. Excessive soil moisture and nitrogenous manure should be avoided.

Literature:

1924. Burgwitz, G. K. Eine durch *Bacterium lycopersici* n. sp. verursachte tomatenfruchtfäule. Zeitschr. f. Pflanzenkr. 34: 303–312, 1924.

1924. Burgwitz, G. K. Die Faule der Tomatenfrüchte verursacht durch *Bact. lycopersici* n. sp. Morbi Plantarum 13: 42–50, 1924.

1924. Burgwitz, G. K. On the question of the transmission of the tomato fruit "blossom end rot" caused by *Bact. lycopersici.* Morbi Plantarum (Leningrad) 13: 128–130, 1924. The writer claims to have shown by experiments that the organism overwinters on the seed. Plants from such seed develop normally and produce healthy fruit but less in quantity than normal.

Bacterium maculicola (McC.) McCulloch, 1928

Motile by one to five polar flagella; 0.8–0.9 x 1.5–3.0μ; chains; no spores; aerobic; Gram negative; not acid fast; agar colonies at first round, white, smooth, glistening becoming dull to dirty white, margins undulate, slightly wrinkled, medium slightly greened; gelatin slowly liquefied; no gas; feeble production of ammonia, indol and hydrogen sulphide; nitrates not reduced; growth moderate in Cohn's, Uschinsky's and Fermi's solutions; Fermi's pale green fluorescent; milk not curdled; litmus milk blued; optimum temperature 24–25°C.; maximum 29°C.; minimum below 0°C.; thermal death point 46°C.

Synonymy:

Bacterium maculicolum McCulloch, 1911.
Pseudomonas maculicolum (McCulloch) Stevens, 1913.
Phytomonas maculicola (McCulloch) Bergey et al., 1923.

Symptoms: This organism causes stomatal blotching or speckling of the green leaves on veins and parenchyma. Spots are usually small varying from 1–3 mm. in diameter. These may coalesce to form elongated irregular spots which make the leaf look ragged and badly infected leaves may turn yellow and fall. At first the spots are water-soaked later becoming brownish to purplish gray. When veins or midribs are attacked the leaves become puckered and distorted. Gray to black discolorations may also occur on the heads.

Hosts: (natural) *Brassica oleracea botrytis,* (artificial) *Brassica oleracea capitata.*

Geographical distribution: Connecticut, New York, Virginia, Florida, Alabama, California, Washington, Denmark, Algeria; probably in Mississippi, Louisiana, Texas, Australia.

Control: According to Clayton (1924) sterilization of seed in hot water (122°F. for 30 minutes) is beneficial but the disease is seldom severe enough to make this necessary. Goldsworthy (1926) says the red bordered stink bug *Euryopthalmus convivus* is a disseminating agent.

Literature:

1911. McCulloch, L. A spot disease of cauliflower. U. S. Dept. Agr., B. P. I. Bul. 225: 1–15, 1911.
1913. Stevens, F. L. The fungi which cause plant disease, p. 28, 1913.
1920. Smith, E. F. McCulloch's cauliflower spot. An introduction to bacterial diseases of plants, pp. 300–313, 1920.
1920. U. S. Dept. Agr., B. P. I., The Plant Disease Bulletin, Suppl. **10**: 239, 1920.
1923. Bergey's Manual of Determinative Bacteriology, p. 189, 1923.
1923. Ferdinandsen, C. *Bacterium maculicolum* McCulloch paa Europaeisk Grund. Nord Jardbrugsforskn. No. 5–8: 467–474, 1923.
1924. Clayton, E. D. Investigations of cauliflower diseases on Long Island. New York (Geneva) Agr. Exp. Sta. Bul. 506: 3–15, 1924.
1925. Gram, E. Maanedlige Oversigter over Sygdomme hos Kulturplanter fra Statens plantepatologiske Forsøg. 5 pp., July, 1925.
1926. Goldsworthy, M. C. Studies on the spot disease of cauliflower; a use of serum diagnosis. Phytopath. **16**: 877–884, 1926.

1928. Goldsworthy, M. C. The production of agglutinins by phytopathogenic bacteria. Phytopath. 18: 277–288, 1928. He used *Pseudomonas cerasus* var. 28 and var. 29, and *Bacterium maculicolum.*

1928. McCulloch, L. *Bacterium maculicola* (McC.) nom. emend. Syn. *Bacterium maculicolum.* Phytopath. 18: 460, 1928.

Bacterium (?) mali Brzezinski, 1903

Motile (flagella not stained); 1.0–3.0 x 0.6–0.7μ; chains; capsules; Gram negative; grayish white on agar; aerobic; gelatin liquefied; starch destroyed. He made his isolations without pouring plates and there is no assurance that he was working with pure cultures. The results of his inoculations were not satisfactory.

Symptoms: This organism is said to cause cankers or tumors on the branches and yellow brown strands in the interior of wood of apple trees.

Host: *Malus sylvestris.*

Geographical distribution: Central Europe.

Literature:

1903. Brzezinski, M. J. Le chancre des arbres, ses causes et ses symptoms. Bul. Intern. Acad. Sci. Crocovie, Classe Sci. Math. Nat., 95–129, 1903.

Bacterium malvacearum (E. F. Smith) E. F. Smith, 1905

No spores; motile by one polar flagellum; Gram negative; not acid fast; gelatin feebly liquefied; milk curdled by lab ferment and slowly digested; nutrient agar colonies round, thin, flat, smooth, glistening, pale yellow, more or less radiate mottled; beef gelatin colonies yellow, circular, with numerous spatulate finger like projections; blood serum slowly liquefied; growth on potato cylinders abundant, smooth, glistening, filling the surrounding liquid, wax yellow, browning with age; strong diastatic action; moderate clouding in beef bouillon and a pale yellow rim; moderate growth in Uschinsky's solution with pale rim; little or no growth in Cohn's; nitrates not reduced; no indol; optimum temperature 25°–30°C.; maximum 36°–38°C.; minimum about 10°C.; thermal death point between 50° and 51°C.

Synonymy:

Pseudomonas malvacearum E. F. Smith, 1901.
Phytomonas malvacera (E. F. Smith) Com. S. A. B., 1923.
Phytomonas malvacearum (E. F. Smith) Bergey et al., 1925.
See *Bacillus gossypina* Stedman.

Symptoms: This is primarily a disease of the parenchyma rarely penetrating the bundles. Leaf lesions first appear as small water-soaked translucent dots between the veins. As they enlarge they become angular and brown and coalescing cause the leaves to turn yellow and fall. Bracts and veins may also become spotted. If the bolls are small when attacked they drop off. On larger bolls the green water-soaked spots become brown or black and shrunken and the lint becomes wet, brown stained and rotten. Pods may become one-sided in development. On the stems the elongated water-soaked spots end in long, sunken black stripes and the branch shrivels and dies or breaks over. Bacterial exudate dries as yellowish granules or crusts. Probably a large proportion of

boll rots due to fungi enter through angular leaf spot lesions. Angular leaf spot, black arm, boll rot, gummosis.

Hosts: *Gossypium* sp., *Thurberia thespesioides.*

Geographical distribution: "Probably the disease occurs in all the cotton-growing regions of the world" (Smith, 1920): Southern United States, South and East Africa, India, Ceylon, Western Asia (Turkestan), China, Tanganyika (possibly), Fiji, Philippines, Barbados, West Indies, Egypt, Sudan.

Control: Only seed from disease-free fields should be used but if this is not possible the most effective means of control is immersion of seed in concentrated sulphuric acid (about 3 gallons to 100 lbs. of seed) for fifteen minutes, with constant stirring, rinsing in running water twenty minutes, then placing in mercuric chloride 1:1,000 for fifteen minutes and finally drying. This is an expensive method. Sherbakoff (1927) found that the most economical treatment for delinting cotton seed is that with diluted sulphuric acid. One part of concentrated sulphuric acid diluted with five parts by volume of water, and one part of this diluted acid added to ten parts by volume of cotton seed will effectively delint seed if mixed thoroughly. Seed must then be spread in a thin layer in a dry place for about seven days. If concentrated acid is used the minimum amount is seventeen parts of cotton seed and one part by volume of concentrated acid. This should be stirred thoroughly for 5 to 10 minutes and allowed to remain on the seed for 15–20 minutes. Liming of cotton seed after treatment with sulphuric acid was found to give as good results as thorough washing. Sufficient air-slacked lime should be used to cover the seed thoroughly. Artificial heat has been suggested as a means of control. The organism is killed by exposure for two hours at 52–55°C. according to Snowden, 1926. Brown (1928) says "Pima cotton grown on soil containing 0.2 to 0.4 per cent of sodium chloride is resistant to angular leaf spot. When the concentration of sodium chloride is near the limit of tolerance of cotton (0.4 per cent) Pima cotton is practically immune to the disease." Ashby (1926) found Izal 1–250 parts water for 15 minutes gave effective control on seed with little lint. Corrosive sublimate for 15 minutes is also effective. At the Georgia Station (1929) control was secured by treating seed with 20 per cent mercuric chloride dust (4 oz. per bushel), mercuric resinate dust (saturated), and DuPont dust No. 12 (4 oz. per bushel) without delinting.

To control stem end and center rot of tomato: Practice frequent cultivation to encourage steady growth and prevent the formation of fissures; select varieties which do not crack easily; use clean seed; practice sanitary field methods; spray frequently with Bordeaux to reduce the bacterial and fungus flora of the surface of the fruit.

Literature:

1885. Riley, C. V. The Boll Worm. Rept. U. S. Entom. Com. 4: 367–368, 1885. He describes boll rot and thinks Steele mistaken in attributing it to the work of the boll worm. He states that it has been destructive at times since 1810.

1891. Atkinson, G. F. Black rust of cotton. Bot. Gaz. **16**: 62, 1891. Alabama Agric. Exp. Sta., Auburn, Bul. 27: 10, 1891. He was the first to describe the watery angular leaf spots.

1892. Atkinson, G. F. Angular spots of cotton. In Some Diseases of Cotton. Alabama Agric. Exp. Sta. Bul. 41: 54–55, 1892. He

describes and figures the dark angular spots on the leaves and says they are full of bacteria but his inoculations were not successful.

1896. Atkinson, G. F. Diseases of cotton—Angular leafspot, in the cotton plant: Its history, botany, chemistry, culture, enemies and uses. U. S. Dept. Agric. Off. Exp. Stas. Bul. 33: 286–287, 1896. "This disease is named from the dark angular spots which appear in the leaf." "In the very earliest appearance of the spots, when the watery condition is coming on, these spots swarm with bacteria. This suggested that it might be a bacterial disease. Cultures of the organism present were obtained and inoculations of healthy leaves were made at different times but without producing the disease."

1900. Earle, F. S. Diseases of cotton. Alabama Agric. Exp. Sta. Bul. 107: 309–310, 1900. "I am of the opinion that the disease is directly due to the action of the accompanying bacteria."

1901. Smith, E. F. The cultural characters of *Pseudomonas hyacinthi*, *Ps. campestris*, *Ps. phaseoli*, and *Ps. stewarti*—four one flagellate yellow bacteria parasitic on plants. U. S. Dept. Agr., Div. Veg. Phys. and Path., Bul. 28: (organism named here, p. 153), 1901.

1904. Lewton-Brain, L. Cotton boll rot; leaf diseases. West Indian Bul. 4: 265, 345, 1904.

4 1905. Jaczewski, A. Gummosis of cotton. Yearbook of Information on Diseases and Injuries of Cultivated and Wild Useful Plants (Russian). Ministry of Agr. and Imp. Domains, Dept. Agric., St. Petersburg, 1903: 148, 1904. He states that in 1903 Mr. Schroeder sent diseased cotton plants from Tashkent, Turkestan, affected with bacterial gummosis of the stem.

1905. Smith, E. F. Bacteria in relation to plant diseases 1: 171, 1905.

1907. Lewis, A. C. Angular leaf spot in cotton anthracnose, and cotton "rusts." Georgia State Board of Entomology, Atlanta, Ga., Bul. 24: 66–67, 1907.

1907. Orton, W. A. Bacterial blight in Sea Island cotton: its culture, improvement and diseases. U. S. Dept. of Agric., Farmers' Bul. 302: 41–43, 1907. "Egyptian cotton is peculiarly subject to this trouble—so much so that its cultivation in the south-eastern states appears to be impracticable."

1908. Agriculture in Nyasaland. The Agricultural News, Barbados. 7: 391, 1908. This article states that bacterial blight of cotton due to angular leaf spot is common in British Central Africa.

1912. Edgerton, C. W. Flower infection with cotton boll rots. Phytopath. 2: 23–27, 1912.

1912. Edgerton, C. W. The rots of the cotton boll. Agric. Exp. Sta. of Louisiana State Univ. and A. & M. College, Baton Rouge Bul. 137: 8–19, 1912.

1915. Nowell, W. Fungoid and bacterial diseases. West Indian Bulletin 15: 135, 146, 1915. *Bact. malvacearum* is reported from St. Vincent, Montserrat, St. Kitts, Nevis, Antigua, Virgin Islands.

1915. Rolf, F. M. Angular leaf spot of cotton. South Carolina Agr. Exp. Sta. of Clemson Agr. College, Bul. 184: 5–30, 1915.

1916. Bovell, J. R., and J. S. Dash. Report Dept. Agriculture Barbados 1914–1915: 20–25, 43, 1916. This report includes data on late cottons badly affected with black arm, angular leaf spot, and bacterial boll disease, all due to *Bacterium malvacearum*.

1916. Faulwetter, R. C. Physiology of *Bacterium malvacearum* Smith. Ann. Rept. South Carolina Agr. Exp. Sta. 29: 49–64, 1916.

1917. Faulwetter, R. C. Dissemination of *Bacterium malvacearum*. Phytopath. **7**: 64, 1917. (Abstract.)

1917. Faulwetter, R. C. Dissemination of the angular leafspot of cotton. Journ. Agr. Res. **8**: 457–475, 1917.

1919. Doidge, E. M. The rôle of bacteria in plant diseases. South African Journ. Sci. **16**: 84–85, 1919.

1919. Faulwetter, R. C. The angular leaf spot of cotton. South Carolina Agr. Exp. Stat. Bul. 198: 3–29, 1919.

1920. Smith, E. F. An introduction to bacterial diseases of plants, pp. 314–339, 1920. Pp. 317–319 Smith says he has proved the identity of the disease as it occurs in Asia and Africa with that occurring in the United States.

1921. Elliott, J. A. Arkansas cotton diseases. Arkansas Agr. Exp. Sta. Bul. 173: 6–8, 1921.

1921. Gilbert, W. W. Cotton diseases and their control. U. S. Dept. Agr., Farmer's Bul. 1187: 17–21, 1921.

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1925. Bergey's Manual of Determinative Bacteriology, p. 198, 1925, (2nd ed.).
1925. Brookes, R. St. John, K. Nain and M. Rhodes. The investigation of phytopathogenic bacteria by serological and biochemical methods. Journ. Path. and Bakt. 28: 203–209, 1925. See *Bacillus carotovorus*.
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1929. Massey, R. E. Black arm disease of cotton. The development of *Pseudomonas malvacearum* E. F. Smith within the cotton plant. Empire Cotton Growing Review 6: 124–153, 1929.

1929. Massey, R. E., and M. C. Hattersley. Black arm disease of cotton. Empire Cotton Growing Review 6: 248–249, 1929.

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1929. Plant diseases. 41st Ann. Rept. Georgia Agr. Exp. Sta. for 1928: 25–26, 1929.

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Bacterium marginale Brown, 1918

Motile by one to three polar flagella; 0.42–1.25 x 0.83–2.08μ; majority 0.83 x 1.45μ; short chains; capsules; no spores; aerobic; Gram negative; not acid fast; agar colonies cream colored becoming yellow, round, smooth, thin, agar becomes brilliant green; bouillion heavily clouded becoming apple green; growth on potato cylinders scanty, dirty cream colored, later a warm-buff; diastatic action feeble; gelatin slowly liquefied; ammonia produced; nitrates reduced; no indol; no hydrogen sulphide; heavy clouding and heavy pellicle in Uschinsky's solution and medium Veronese green; no growth in Fermi's or Cohn's; milk curdled and turned green; no gas; acid from dextrose and sucrose; optimum temperature 25°–26°C.; maximum 38°C.; minimum below 0°C.; thermal death point 52–53°C.

Synonymy:

Phytomonas marginalis (Brown) Bergey et al., 1923.

Pseudomonas marginalis (Brown) Stapp, 1928.

Mehta and Berridge, 1924, found *Bact. marginale* identical in cultural and morphological characters and in pathogenicity on lettuce with *B. pyocyaneus.* See note by Paine and Branfoot (1924) under *Bacterium aptatum.*

Symptoms: The margins of the diseased lettuce leaves become dark brown or almost black. At first soft, the brown diseased areas become parchment-like after a few days. The infected margins are from 0.5 to 1.5 cm. in width. Scattered over the leaf are yellowish red spots resembling rust spots. The spots may coalesce forming brown or black areas. The Kansas lettuce disease.

Host: *Lactuca sativa.*

Geographical distribution: New Jersey, Kansas.

Control: "As *Bacterium marginale* is a soil organism, care should be taken in watering the plants in the greenhouses that the roots only of lettuce are watered. Soil should not be washed up nor spattered on the leaves. Subirrigation is a safeguard. Good ventilation will almost, if not entirely prevent the disease." For control of stem end and center rot of tomato see *Bact. malvacearum.*

Literature:

1900. Migula, W. System der Bakterien 2: 884–885, 1900. *Pseudomonas aeruginosa* (Schröter) Migula, Synonyms: *Bacterium aeruginosum* Schröter, 1872; *Bacillus aeruginosus* Schröter, 1886; *Bacillus pyocyaneus* Gessard, 1882.

1918. Brown, N. A. Some bacterial diseases of lettuce. Journ. Agr. Res. **13**: 367–388, 1918.

1923. Bergey's Manual of Determinative Bacteriology, p. 182, 1923.

1924. Mehta, M. M., and E. M. Berridge. Studies in Bacteriosis XII. *B. pyocyaneus* as a cause of disease in lettuce and the identity of *B. marginale* with this organism. Annals of Appl. Biol. **11**: 318–323, 1924.

1924 Paine, S. G., and J. M. Branfoot. Studies in Bacteriosis XI. A bacterial disease of lettuce. Ann. Appl. Biol. **11**: 312–317, 1924. Organism probably a strain of *Bacterium pyocyaneus.*

1925. Brookes, R. St. John, K. Nain and M. Rhodes. The investigation of phytopathogenic bacteria by serological and biochemical methods. Journ. Path. and Bakt. **28**: 203–209, 1925. See *Bacillus carotovorus.*

1926. Brown, N. A. A stem-end and center rot of tomato caused by various unrelated organisms. Journ. Agric. Res. **33**: 1009–1024, 1926.

1928. Stapp, C. Schizomycetes (Spaltpilze oder Bakterium). In Sorauer's Handbuch der Pflanzenkrankheiten 2 (fünfte auflage): 288–289, 1928.

Bacterium marginatum McCulloch, 1921

Motile by one to four bipolar flagella; 0.5–0.6 x 0.8–1.8μ; capsules; no spores; aerobic; Gram negative; not acid fast; beef agar colonies white, circular becoming more or less irregularly lobed, center smooth and surrounded by a wide border which is thin at first becoming thick and contoured; gelatin liquefied; blood serum softened; milk curdled and peptonized and becoming very viscid; litmus milk promptly reduced; no gas; acid from dextrose, galactose, lactose, mannit, maltose, sucrose, glycerin; nitrates not reduced; slight amounts of indol, ammonia and hydrogen sulphide produced; grows well in Uschinsky's, Fermi's

and Cohn s solutions; optimum temperature 30–32°C.; maximum 40°C.; minimum 8–9°C.; thermal death point about 53°C.

Synonymy: *Phytomonas marginata* (McCulloch) Bergey et al., 1923.

Symptoms: Leaf lesions are usually confined to the basal fleshy portion and are first visible as tiny specks of bright reddish-brown color, slightly elevated. These enlarge to circular or elongated spots, the center sunken, dark brown to black, the margin slightly elevated and darker in color. Fibrovascular bundles stand out prominently in the sunken areas. When lesions coalesce necrotic areas are formed in which all the parenchyme tissue is destroyed. Infected tissue is usually dry and firm but under moist conditions it may progress like a soft rot. Eventually the vessels become blocked with a brownish gum-like substance and the leaf parts above die. In severe infection the whole plant falls over. Husk lesions are oval to elongated, sunken brown to black, and split longitudinally the margins becoming ragged and the texture and color of burned tissues. Corm lesions begin as pale yellow, water-soaked circular spots, the color deepens to brown or almost black and the spots finally become shallow depressions surrounded by elevated margins. They are usually 2–6 mm. in diameter but may coalesce to form large irregular sunken areas. They are horny or brittle in texture, are easily removed, leaving saucer-shaped pits, and exude a gummy substance. The organism lives from season to season on the corms. Scab, stem rot, neck rot.

Hosts: *Gladiolus* sp., *Iris* sp.

Geographical distribution: Widespread through the United States: Florida, Virginia, Maryland, Pennsylvania, Michigan, Ohio, Indiana, California; Canada, Czechoslovakia, Holland.

Control: Some success has resulted from treating corms with either mercuric chloride (1:1,000) for 1 hour or formalin (1–120) for 2 hours, or semesan (1:400) for 12 hours. Crop rotation should be practiced as the organism lives over winter in the soil. Gladiolus should not be planted on the same soil more than once in three or four years. The growth of healthy corms in disease-free soil is the only complete control known.

Literature:

1921. McCulloch, L. A bacterial disease of gladiolus. Science **54:** 115–116, 1921.

1923. Bergey's Manual of Determinative Bacteriology, p. 188, 1923.

1924. McCulloch, L. A leaf and corm disease of gladioli caused by *Bacterium marginatum*. Journ. Agr. Res. **29:** 159–177, 1924.

1924. McCulloch, L. Two bacterial diseases of gladiolus. Phytopath. **14:** 63–64, 1924. (Abstract.)

1926. Massey, L. M. Treating gladiolus bulbs for disease. Flow. Grow. **13:** 235, 1926.

1926. Tuly, N. E. Is scab a disease? Flor. Rev. **57:** 41, 1926. He thinks scab is caused by wire worms.

1927. Bryan, M. K. Beef infusion versus beef extract media. Phytopath. **17:** 413–414, 1927 (note).

1927. Drayton, F. L. Gladiolus diseases. Rept. Canada Exp. Farms (Rep. Dom. Bot.) 1926: 11–15, 1927.

1927. Nelson, R. Some diseases of the gladiolus in Michigan. Bul. Mich. Gladiolus Soc. **1:** 4–6, 1927.

1927. Wedgworth, H. H. Gladiolus scab. Quart. Bul. State Plant Board Mississippi 7: 6–10, 1927.
1927. Gladiolus diseases. Off. Bul. Amer. Glad. Soc. 4 (5): 8–9, 1927.
1928. Baudys, Ed. Bakteriosa meciku (Bakteriose des gladiolus). Ochrana Rostlin 8: 49–51, 1928. (German Summary.) *B. marginatum.* He says he found the disease on bulbs and leaves of gladiolus in Mähren, Czechoslovakia in 1928. It was found for the first time in Europe in Frankreich, in 1894.
1929. Drayton, F. L. Recommendations for the control of gladiolus diseases. Glad. Rev. Amer. Glad. Soc. 6: 11–12, 1929.
1929. Drayton, F. L. Bulb growing in Holland and its relation to disease control. Scient. Agric. 9: 508–509, 1929. *Bacterium marginatum* is reported on gladiolus in Holland. Methods for eradication of the disease are recommended.
1929. Patel, M. K. Viability of certain plant pathogenes in soils. Phytopath. 19: 295–300, 1929.

Bacterium martyniae Elliott, 1924

Motile by one to several bipolar flagella; 0.5–0.7 x 1.3–2.2μ; chains; capsules; no spores; aerobic; Gram negative; not acid fast; beef agar colonies round, smooth, white, glistening, raised, later becoming umbonate, and medium greened; growth in beef bouillon moderate, light green with age, clouding in bands, with thin pellicle; clouding in Cohn's solution moderate with long triangular crystals; clouding moderate in Uschinsky's solution with heavy pellicle; clouding light in Fermi's solution with heavy pellicle; gelatin liquefied; blood serum cleared and slightly liquefied; no indol; hydrogen sulphide produced; little if any diastatic action; soft acid curd formed in milk and completely peptonized in 14 days; litmus in milk reduced; nitrates promptly reduced; no gas; acid from sucrose, dextrose, galactose, arabinose; optimum temperature about 25°C.; maximum 37°C.; minimum 1.5°C.; thermal death point 49°C.

Synonymy:

Pseudomonas martyniae (Elliott) Stapp, 1928.

Phytomonas martyniae (Elliott) Bergey et al., 1930.

Symptoms: The first signs of the disease are round to angular, sunken, translucent spots 1–2 mm. in diameter. As they grow older, narrow raised brown margins develop. These spots coalesce to form irregular patches of dry, light brown tissue with scattered translucent dots. By inoculation water-soaked lesions were produced on the petioles which collapsed at the point of attachment to the leaf. Entire leaves and petioles died. From the petioles infection passed into the stem and entire plants collapsed. Infection also progressed from the stem into partially developed fruits which were at first water-soaked and later became brown and shriveled.

Host: *Martynia louisiana.*

Geographical distribution: Kansas.

Control: Diseased leaves and plants should be destroyed as soon as lesions appear, and only seed from healthy pods should be used for planting.

Literature:

1924. Elliott, C. A bacterial leafspot of martynia. Journ. Agr. Res. 29: 483–490, 1924.

1928. Stapp, C. Schizomycetes (Spaltpilze oder Bakterien). In Sorauer's Handbuch der Pflanzenkrankheiten 2 (fünfte auflage). 278, 1928.
1930. Bergey's Manual of Determinative Bacteriology, p. 242, 1930. (3rd. ed.)

Bacterium (?) matthiolae Briosi, 1912

0.4–0.6 x 2.0–4.0μ; Gram positive; aerobic; gelatin liquefied and greened; growth on agar whitish, slightly elevated, wet glistening, margin lobed; good growth in plain broth with pellicle and dirty white sediment and greening of medium; growth on potato gray-white, wet, rather elevated becoming pale yellow to brown; no hydrogen sulphide.

Synonymy: *Phytomonas matthiolae* (Briosi) Bergey et al., 1930.

Symptoms: The first signs of the disease are pale green spots on the leaves followed by small, irregular more or less punctiform spots on the petioles. Young leaves are more or less deformed and the margins curl upward. Development of the inflorescence is retarded and the flowers are of no commercial value. Woody vessels of young branches turn yellow or brown, and a corky layer forms around the infected vessels. Infection of the stalk starts in the primary wood extending in toward the pith and out into the secondary wood. The walls of the vessels turn brown and a brown or black substance fills the lumen of cells of the diseased tissue. Similar infection takes place in the roots.

Host: *Matthiola incana annua.*

Geographical distribution: Liguria, Italy.

Control: Spraying with Bordeaux mixture did not control the disease. The writers recommend crop rotation, removal and burning of diseased plants, seed treatment with corrosive sublimate and selection of resistant varieties.

Literature:

1912. Briosi, G., e L. Pavarino. Una mallatia batterica della *Matthiola annua* L. (*Bacterium matthiolae* n. sp.). Atti R. Accad. Naz. Lincei Rend. Cl. Sci. Fis., Mat. e Nat. **21**: 2nd Sem. 216–220, 1912.
1912. Briosi, G., e L. Pavarino. Batteriosi della *Matthiola annua* L. (*Bacterium matthiolae* n. sp.) Atti R. Ist. Bot. Univ. di Pavia ser. 2, **15**: 135–141, 1912.
1914. Smith, E. F. Bacteria in Relation to Plant Diseases **3**: 277–279, 1914.
1930. Bergey's Manual of Determinative Bacteriology, p. 243, 1930. (3rd. ed.)

Bacterium medicaginis (Sackett) E. F. Smith, 1920

Motile by one to four polar flagella; 0.5–0.8 x 1.2–2.4μ; chains; no capsules; no spores; Gram negative; aerobic; nutrient agar colonies gray-white becoming fluorescent, glistening; gelatin not liquefied; nitrates not reduced; no acid or gas from dextrose, sucrose, lactose, glycerin; milk coagulated but casein not digested; no indol; no hydrogen sulphide; ammonia produced; no diastatic action on starch; thermal death point 49°–50°C.

Synonymy:

Pseudomonas medicaginis Sackett, 1910.

Phytomonas medicaginis (Sackett) Bergey et al., 1923.

Symptoms: This is primarily a stem infection. In early stages stems are watery, semi-transparent, yellowish to olive green along one side. Usually the first three to five internodes are the worst infected. Exudate oozes out in droplets from the diseased tissue drying in a short time with a glistening finish that gives the stem the appearance of having been varnished. Such stems are rough to the touch. These stems blacken in six to eight weeks, become very brittle and are easily broken. Infected plants show a spindling growth, the leaves are often dwarfed, narrow and light green. One-year-old plants may show blackened areas in the crown and black streaks which run down into the tap root. The blackening may increase until the crown buds are destroyed and the plant dies. The disease appears to run its course with the first cutting and does not appear again until the next year. Bacterial stem blight.

Host: *Medicago sativa.*

Geographical distribution: Colorado, Utah, New Mexico, Nebraska, Kansas, Indiana.

Control: It is recommended that frosted alfalfa be clipped as soon as danger from late frosts is past. This removes the frost-split stems as sources of infection and affords opportunity for new growth.

Literature:

1906. Paddock, W. A new alfalfa disease. Colorado Agr. Exp. Sta., Press Bul. 28: 2 pp., 1906.

1909. Sackett, W. G. Some bacterial diseases of plants. Colorado Agr. Exp. Sta. Bul. 138: 3–23, 1909. Preliminary report on a bacterial disease of alfalfa.

1910. Sackett, W. G. A bacterial disease of alfalfa caused by *Pseudomonas medicaginis* Sackett n. sp. Science **31**: 553, 1910.

1910. Sackett, W. G. A bacterial disease of alfalfa. Colorado Agr. Exp. Sta. Bul. 158: 1–32, 1910.

1910. Sackett, W. G. A new alfalfa disease, stem blight. Colorado Agr. Exp. Sta. Bul. 159: 1–15, 1910. (Abbreviated ed. of Bul. 158.)

1914. O'Gara, P. J. Occurrence of bacterial blight of alfalfa in the Salt Lake Valley, Utah. Science (n. s.) **39**: 905–906, 1914.

1916. Melchers, L. E. Plant diseases affecting alfalfa. Rept. Kansas State Bd. Agr. 35: 348–349, 1916. The disease has not been seen in Kansas lately.

1920. Smith, E. F. An Introduction to Bacterial Diseases of Plants, p. 474, 1920. *Bact. medicaginis* (Sackett) E. F. S.

1923. Bergey's Manual of Determinative Bacteriology, p. 179, 1923.

1927. Gardner, M. W. Indiana Plant Diseases. Proc. Indiana Acad. Sci. **36** (1926): 231–247, 1927.

Bacterium medicaginis var. phaseolicola (Burkholder) Link and Hall, 1927

Motile by one polar flagellum; 0.5–1.25 x 1.5–3.0μ; chains; no spores; no capsules; Gram negative; not acid fast; facultative anaerobe; nutrient agar colonies white to creamy, slow to moderate growing, concentrically ringed, margins undulate, glistening, butyrous becoming brittle with age; scant growth on potato cylinders and medium darkened; gelatin colonies slow growing, circular,

raised, somewhat wrinkled; clouding in nutrient broth in 24 hours and thin pellicle; litmus milk becomes intense blue, no curd formation nor peptonization occurs; no gas; small amount of acid from dextrose and sucrose; nitrates not reduced; gelatin not liquefied; no diastatic action; no indol; no hydrogen sulphide; a light yellow green turbid growth in Uschinsky's solution with pellicle; growth in Fermi's slightly green with heavy pellicle; no growth in Cohn's solution; thermal death point about 49°C.; optimum temperature 25°–30°C.; maximum 36°–37°C.; minimum about 0°C.

Synonymy:

Phytomonas medicaginis var. *phaseolicola* Burkholder, 1926.

See *Bacterium puerariae.*

Symptoms: This organism causes wilting of a part or all of the plant. Leaves wilt and turn brown and young pods may wither and produce no seed. When conditions are not favorable for wilting a distinct dwarfing takes place. In dwarfed or slightly wilted plants the top leaves become crinkled and mottled with pale and dark green areas. Green wilted areas which become dry and brown with light, yellow green borders, occur on leaves in spots ½ inch in diameter to the entire leaflet. Reddish necrotic lesions extend longitudinally along the stem and gray viscid exudate oozes out from cracks in the stem. Pods are very susceptible to infection. The round water-soaked lesions dry and become irregular in shape and brick red to brown with a silvery incrustation. On white seed, maize yellow to cream-colored spots may be small or destroy the entire seed. Badly infected seed is small and wrinkled. Hedges (1928) reports never having observed wilting as a symptom of the disease in the field. According to her observations the most striking symptoms are the water-soaked leaf spots with wide, pale green or yellowish green halos about them. These spots later become brown and dry. Halo spot; halo blight.

Hosts: *Phaseolus coccineus, Phaseolus lunatus macrocarpus, Phaseolus vulgaris.*

Geographical distribution: New York, Wisconsin, Montana, Wyoming, Colorado, Utah, Florida, Georgia, South Carolina, Germany.

Control: The disease is seed-borne. Results of experiments indicate "that practical resistance may be found for this disease." Halo blight has not been observed on Great Northern. Refugee appears to be quite resistant.

Literature:

1926. Burkholder, W. H. A new bacterial disease of bean. Phytopathology **16**: 915–927, 1926.

1927. Link, G. K. K., and K. L. Hull. Smoothness and roughness and spontaneous agglutination of *Bacterium citri, Bact. medicaginis* var. *phaseolicola, Bact. phaseoli sojense* and *Bact. tumefaciens.* Bot. Gaz. **73**: 412–419, 1927.

1928. Hedges, F. Bacterial diseases of beans in some western commercial seed-growing and canning areas and southern trucking sections in 1927 and 1928. U. S. Dept. Agric., B. P. I., Plant Disease Reporter **12**: 121–122, 1928.

1928. Link, Geo. K. K., and A. DeS. Link. Further agglutination tests with bacterial plant pathogens. I. *Bacterium campestre-Bact. phaseoli* group; *Bact. medicaginis* var. *phaseolicola; Bact. tumefaciens.* Bot. Gaz. **85**: 178–197, 1928.

1928. Link, G. K. K., and W. H. Taliaferro. Further agglutination tests with bacterial plant pathogens. II. Soft rot group: *Bacillus aroideae* and *B. carotovorus*. Bot. Gaz. 85: 198–207, 1928.

1929. Stapp, C., und W. Kotte. Die Fettfleckenkrankheit der Bohne, eine für Deutschland neue, durch Bakterien herforgerufene Pflanzenkrankheit. Nachrichtenblatt für den Deutschen Pflanzenschutzdienst. 9 (No. 5): 35–37, 1929. Optimum temperature for growth 25–30°C., maximum temperature 36–37°, minimum about 0°, thermal death point 49°–50°C.

Bacterium melleum Johnson, 1923

Motile by one to several polar flagella; 0.5–0.8 x 1.0–2.4μ; chains; capsules; no spores; Gram negative; not acid fast; aerobic; potato dextrose agar colonies round, glistening, smooth, convex, viscid, yellow with opaque centers, with yellow tinge in the agar; gelatin liquefied; blood serum gradually liquefied; growth on potato cylinders abundant, brownish yellow; diastatic action feeble; milk promptly coagulated and slowly peptonized; litmus reduced; good growth in Fermi's and Cohn's solutions; no indol; no ammonia; no hydrogen sulphide; nitrates not reduced; no acid and no gas from carbohydrates; optimum temperature 26°–28°C.; maximum 35°–36°C.; minimum 7°–9°C.; thermal death point 57°C.

Synonymy:

Pseudomonas mellea (Johnson) Stapp, 1928.

Phytomonas mellea (Johnson) Bergey et al., 1930.

Symptoms: In the field young lesions are usually round with a small central fleck surrounded by a chlorotic halo. This halo may not appear at all, the tissue around the point of infection turning brown or sometimes white. Lesions may be limited by the veins or follow the veins forming elongated spots. Lesions are 1 mm. to 1 cm. in diameter frequently coalescing and involving large irregular areas of the leaf. Old lesions are distinctly brown or brownish white. Spots in the seed bed are small and more angular and the chlorotic area is less distinct. The disease occurs chiefly on the lower leaves. Rust, Wisconsin tobacco disease.

Hosts: *Lycopersicum esculentum, Nicotiana glauca, Nicotiana rustica, Nicotiana tabacum.*

Geographical distribution: Kentucky, Wisconsin.

Control: Plants from infected seed beds should be avoided.

Literature:

1923. Johnson, J. A bacterial leaf spot of tobacco. Journ. Agr. Res. 23: 481–493, 1923.

1928. Stapp, C. Schizomycetes (Spaltpilze oder Bakterien) in Sorauer's Handbuch der Pflanzenkrankheiten 2 (fünfte auflage): 275, 1928.

1930. Bergey's Manual of Determinative Bacteriology, p. 241, 1930. (3rd ed.)

Bacterium (?) montemartinii Pavarino, 1911

The organism is very imperfectly described—coccus like 6.0–8.0μ; Gram negative; develops best in presence of oxygen; whitish on agar; gelatin not liquefied. There is no evidence that he was working with pure cultures.

Symptoms: This organism is said to cause large, irregular, depressed, black spots on branches. This necrosis extends through the cortex into the wood.

Host: *Wisteria* sp.

Geographical distribution: Italy.

Literature:

1911. Pavarino, L. Un cancro della Glicine: *Bacterium montemartinii* n. sp. Rivista di Patologia Vegetale 5: 65–68, 1911.

Bacterium mori Boyer and Lambert emend E. F. Smith, 1910

Motile by one to seven polar flagella; 0.9–1.3 x 1.8–4.5μ; no spores; no capsules; chains; Gram negative; strongly aerobic; nutrient agar colonies slow growing, translucent, white, circular, smooth, flat, margins entire becoming undulate; gelatin and blood serum not liquefied; slight diastatic action; growth in beef bouillon best at the top with pellicle; milk cleared without coagulation and somewhat browned; little or no growth in Cohn's solution; copious growth in Uschinsky's solution with heavy fragile pellicle, medium bluish-fluorescent and not viscid; indol production feeble or absent; no gas with carbohydrates; nitrates not reduced; maximum temperature 35°C.; minimum 1°C.; thermal death point 51.5°C.

Synonymy:

Bacillus cubonianus Macchiati, 1892.
Bacterium mori Boyer and Lambert, 1893.
Pseudomonas mori (Boyer and Lambert) Stevens, 1913.
Phytomonas mori (Boyer and Lambert) Bergey et al., 1923.
Bacterium cubonianum Ferraris, 1928.

Smith (1920) in discussing the synonymy of this organism says "Macchiati's name *Bacillus cubonianus* is earler by one year than Boyer and Lambert's name *Bacterium mori*, but unfortunately he made no inoculations and ascribed to his organism characters definitely excluding it from any rôle in the causation of the mulberry disease here described, i.e. formation of endospores, presence of capsule, yellow color on media, liquefaction of gelatin, etc." Ferraris (1928) claims that, since Peglion reproduced the disease with Macchiati's organism which was probably a mixture of two organisms one of them the true pathogen studied by Smith, the synonymy should be *Bact. cubonianum* (nom. nov.) (*B. cubonianus* Macch. pp.; *Bact. mori* (Boy. et Lamb.) E. F. Smith).

Symptoms: The signs of this disease are numerous water-soaked leaf spots which enlarge, coalesce and turn brown or black with surrounding yellow tissue. Leaves attacked when young become distorted. Dark sunken spots occur on midribs and veins. Translucent, longitudinal stripes appear on the young shoots, becoming dark and sunken with translucent borders and with whitish or yellowish bacterial ooze which may exude from the lenticels in the form of cirri. (Smith, 343, 1920.) Both bark and wood are invaded and the shoots either shrivel and die or show one sided growth. The conspicuous dead twigs and brown leaves resemble fire blight of apple and pear but the disease on mulberry cannot be produced by inoculating with the pear-blight organism. Mulberry trees are often stunted and ragged in appearance as a result of the disease but are seldom killed (Smith, 1920).

Hosts: *Morus alba*, *Morus nigra*.

Geographical distribution: United States, France, England, Italy, South Africa, Japan, Russia, Australia.

Control: All blighted branches should be removed and burned. Savastano (1923) advocates moderation in stripping off leaves and tender twigs for sericulture which exposes the tree to bacterial infection. Young mulberry trees should not be planted near old trees if they show any signs of disease. Pasinetti (1928) controlled the spread of the disease by cutting out diseased parts and giving weekly applications of 0.06 per cent corrosive sublimate plus 1.5 per cent slaked lime or 0.2 per cent potassium permanganate with 2 per cent starch.

Literature:

1890. Cornil, A. V., and V. Babes. Les Bactéries. 3rd Ed. **1**: 155–158, 1890. *Ascobacterium luteum* (Babes).

1890. Cuboni, G., et A. Garbarini. Sopra una mallatia del gelso in rapporto colla flaccidezza del baco da seta. Atti R. Accad. Naz. Lincei, Rend Cl. Sci. Fis., Mat. e Nat. **6**: 26, 1890. This is the first report of the disease. He found bacteria abundant in leaf spots.

1892. Macchiati, L. Lo *Streptococcus bombyces* e la flaccidezza, del baco da seta. Staz. Sperim. Agr. Ital. **23**: 225–235, 1892.

1892. Macchiati, L. Sulla biologia del *Bacillus cubonianus* sp. nov. Malpighia **5**: 289–303, 1892.

1893. Boyer, G., et F. Lambert. Sur deux nouvelles maladies du murier. Compt. Rend. Acad. Sci. (Paris) **117**: 342–343, 1893.

1894. Voglino, P. Ricerche intorno alle macchie nere delle foglie del gelso ed alla flaccidezza del baco da seta. Coltivatore **9**: 39, 1894 (from Sorauer 81, 1928).

1895. Prillieux, E. Maladies des Plantes Agricoles **1**: 18–19, 1895.

1896. Cuboni, G. Notizie sulle malattie delle piante coltivate. Bull. di Not. Agr. Roma, Anno 18 (II Sem.): 493–495, 1896.

1896. Peglion, V. Una nuova malattia della canapa (Bacteriosi dello stelo). Malpighia Anno **10**: 556–560, 1896. Abstract in Journ. Roy. Micros. Soc. **2**: 157, 1897. A German translation in Zeitschr. f. Pflanzenkr. **7**: 81–84, 1897. He isolated an organism which appeared to be like *B. cubonianus* but no inoculations were made.

1897. Cavara, F. Intorno alla eziologia di alcune malattie di piante coltivate. Necrosi del Gelso. Staz. Sperim. Agr. Ital. Modena, **30**: 499–504, 1897.

1897. Peglion, V. La Bacteriosi del Gelso. Centralb. f. Bakt. **3**: 10–13, 1897. Reviewed in Riv. Pat. Veg. **5**: 378, 1897.

1897. Peglion, V. Bacteriosi del Gelso. Staz. Sper. Agr. Ital. **30**: 93–106, 1897.

1898. McAlpine. Bakterienkrankheit der Maulbeerbäume. Zeitschr. f. Pflanzenkr. **8**: 142–143, 1898.

1905. Clinton, G. P. Report of the Botanist. Connecticut Agr. Exp. Sta. Rept. for 1904: 319–320, 1905. *Bacillus cubonianus* Macch. (*Bacterium mori* Boy. and Lamb.) was found in the state for the first time in one of the nurseries.

1908. Cuboni, G. Sulla malattie delle piante. R. Staz. Patol. Veg. Roma 1906–07: 40, 1908. He received twigs of mulberry severely

attacked with bacteriosis described by Boyer and Lambert as due to *Bacterium mori* and by Macchiati as due to *Bacillus cubonianus.* He isolated and obtained *Ascobacterium luteum* Babes with which he thinks the two species mentioned above are probably synonymous.

1910. Savastano, L. Patologia arborea applicata, Napoli, p. 216, 1910. Bibliog., p. 577. He reviews the previous work on mulberry blight.

1910. Smith, E. F. Bacterial blight of mulberry. Science **31**: 792–794, 1910. He reviews the literature and describes the organism.

1912. Smith, E. F. Bacterial mulberry blight. Phytopath. **2**: 175, 1912. "Either there are two mulberry diseases or else Macchiati's organism is a saprophyte."

1913. Stevens, F. L. The fungi which cause plant disease, pp. 30–31, 1913.

1914. Bokura, U. (On the bacterial disease of the mulberry tree.) Journal Plant Protection (Tokyo) **1**: 29–31, 149–154, 1914.

1914. Ideta, A. (Handbook of the plant diseases of Japan), pp. 482–483, 1914. *Bacillus cubonianus* Macch. (*Bacterium mori* Boyer et Lambert). (In Japanese.)

1914. Smith, E. F. Identity of the American and French mulberry blight. Phytopath. **4**: 34, 1914. In view of the fact that the French and American diseases have been proved identical he says, "I think the Italian disease should now be reexamined to see if the yellow *Bacillus cubonianus* is not simply a saprophyte."

1915. Arnaud, G., et Ch. Secretain. I. Gommose bacillaire du Murier (*Bacterium mori* Boyer et Lambert). Etudes sur les maladies du Murier en 1913. Annales du Service des Epiphyties **2**: 234–249, 1915.

1915. Doidge, E. M. The South African mulberry blight. *Bacterium mori* (Boy. and Lamb.) Smith. Ann. Appl. Biol. **2**: 115–124, 1915.

1916. Arnaud, G. Études sur les maladies du Murier. Annal. Serv. Epiphyties **3**: 25–30, 1916.

1919. Doidge, E. M. The rôle of bacteria in plant diseases. So. African Journ. Sci. **16**: 65–92, 1919.

1920. Smith, E. F. An Introduction to Bacterial Diseases of Plants, pp. 340–358, 1920.

1923. Bergey's Manual of Determinative Bacteriology, p. 191, 1923.

1923. Savastano, L. Delle epidemie italiane del mal secco negli Agrumeti, Albicoccheti Ficheti, Noceti, e Gelseti. Studio di Clinica Arborea., Ann. R. Staz. Sperim. di Agrumic. e Fruttic. Acireale, **7**: 89–176, 1923.

1924. Osborn, T. G. B. Annual Report of the Consulting Botanist and Vegetable Pathologist. Rept. Min. Agr. S. Australia for year ending June 30, 1923: 68, 1924. *Bacterium mori* was first observed in S. Australia in 1921.

1924. Wormald, H. The mulberry "Blight" in Britain. Ann. Appl. Biol. **11**: 169–174, 1924. The occurrence of bacterial mulberry "blight" in England is here recorded.

1925. Brookes, R. St. John, K. Nain, and M. Rhodes. The investigation of phytopathogenic bacteria by serological and biochemical methods. Journ. Path. and Bakt. 28: 203–209, 1925. See *Bacillus carotovorus*.

1925. Gardner, M. W. Indiana Plant Diseases, 1923. Proc. Indiana Acad. Sci. 34 (1924): 312, 1925. *Bact. mori* reported on mulberry for the first time.

1927. Cecconi, G. Danni prodotti dal vento sui gelsi. Curiamo le Piante! e La Difesa delle Piante contro le Malattie ed i Parasiti. alba 4e 22, N. 8, 147–149, 1927. Trees developed a predisposition to attacks of *Bacillus cubonianus* Macchiati.

1927. Takimoto, S. A bacterial disease of mulberry and its causal organism. Bul. Sci. Fak. Terkult. Kjûsu Imp. Univ. 2: 317–323, 1927. Text in Japanese, English summary, p. 323. Two bacteria found, one white and one yellow, the latter not pathogenic and found at a later stage of the disease; the former identical with *Bact. mori* "in comparison for cultural, morphological and physiological characters."

1928. Ciferri, R. Dominican Republic: A disease of the mulberry new to the country. Internat. Rev. Agric. 19: 98T, 1928. It is probably due to *Pseudomonas mori*, (B. and L.) Stev.

1928. Curzi, M. La lotta contro la malattie bacteriche delle piante. Italia Agricola 6: 323–324, 1928. He states that mulberry bacteriosis is due to *Bacterium mori* and that *Bacillus cubonianus* is only a secondary saprophyte.

1928. Ferraris, T. A proposito della lotta contro la bacteriosi del gelso. Curiamo le Piante! 6: 180–182, 1928.

1928. Hara, S. (A Thesarus of Plant Diseases), p. 95, 1928. (In Japanese.)

1928. Pasinetti, L. Suggerimenti terapeutici contro la batteriosi del gelso. Curiamo le Piante! 6: 2–6, 1928. Bacterial blight of mulberry (*Bacillus cubonianus*) is reported as very severe in Venetia.

1928. Sorauer, P. Handbuch der Pflanzenkrankheiten 2 (fünfte auflage): 79–84, 1928.

Bacterium (?) musae (Gäumann) n. comb.

0.8–1.2μ long; no spores; Gram positive; nutrient agar colonies slow growing, light yellow, round, smooth, margins entire to undulate; gelatin not liquefied; milk coagulated and digested; litmus and methylene blue reduced; nitrates not reduced; no diastatic action; no indol; no hydrogen sulphide; no gas.

Synonymy:

Pseudomonas musae Gäumann, 1921.

See *Bacterium solanacearum* E. F. Smith.

Gäumann's organism is apparently a yellow vascular parasite but he may have confused an unimportant disease due to this organism with the more destructive disease due to *Fusarium cubense*. He states that the signs of the Javan disease are identical with those of the Panama disease due to *Fusarium cubense* but that the signs are not external and are limited in almost all cases to more or less dark staining of vascular bundles which are occupied by fungi and bacteria.

The work of Smith (1910), (1914), Brandes (1919), Carleton (1922), Lee and Serrano (1923) show clearly that the Panama or West Indian disease is due to *Fusarium cubense*.

Symptoms: Infected plants are only about half the size of normal plants. The crown has only 7–10 leaves and an unusual number of dry leaves hang down the stem. A weak fruit stalk is formed—the fruit usually does not ripen entirely and is of poor quality. There are no typical external symptoms. When the attack is more severe external symptoms appear in the form of abnormally developed crown, splitting of the outer leaf sheaths and the premature breaking down and wilting of the leaves. The vascular bundles are discolored, yellow, brown, red, violet in cross section and slime comes out from them.

Hosts: *Musa* sp., *Ravenala* sp., *Strelitzia* sp.

Geographical distribution: Dutch East Indies.

Control: The writer recommends the use of very young suckers for propagation and the treatment of cut surfaces with a disinfectant before planting. All varieties are equally susceptible. The practice of control measures does not offer much hope of success.

Literature:

1903. Earle, F. S. Banana leaf-blight. In "Report on a trip to Jamaica," Journ. N. Y. Bot. Garden 4: 7–8, 1903. He describes a disease of banana causing browning of the vascular bundles which he thinks is due to a bacterial parasite but Smith (1914) found Earle's organism non-infectious.

1910. Smith, E. F. A Cuban banana disease. Science 31: 754–755, 1910.

1914. Smith, E. F. Bacteria in Relation to Plant Diseases 3: 168–170, 1914.

1919. Brandes, E. W. Banana wilt. Phytopath. 9: 339–387, 1919.

1921. Gäumann, Ernst. Over een bacterielle vaat bundelziekte der bananen in Nederlandsch-Indie. Mededeel. van Het Inst. voor Plantenziekten No. 48: 1–135, 1921 (Dutch with English summary).

1922. Brandes, E. W. Onderzoek op grooten afstand betreffende de verwelkingsziekte der Bananen. Teysmannia 33: 294–297, 1922. The author maintains that *Fusarium cubense* is the primary agent in producing the Panama banana disease. Pp. 297–300. Gäumann still maintains that *Fusarium cubense* is only able to attack the banana after it has been discolored by the bacteria.

1922. Carleton, M. A. Note on the Fusarium wilt disease of bananas. Science 56: 663–664, 1922. He repeated Brandes' experiments in Panama with the same results.

1923. Gäumann, E. Ueber zwei Bananenkrankheiten in Niederländisch Indien. Zeitschr. f. Pflanzenkr. 33: 1–17, 1923.

1923. Lee, H. L., and F. B. Serrano. Banana wilt and the Manila hemp plant. Philippine Agr. Rev. 16: 104–107, 1923.

Bacterium nectarophilum Doidge, 1917

Motile by one to five polar flagella; 0.45–0.7 x 0.5–3.0μ; capsules; chains; Gram negative; not acid fast; facultative anaerobe; nutrient agar colonies fluorescent

yellowish white, spreading with irregular margins; nutrient broth heavily clouded, with rim and pellicle; gelatin not liquefied; milk slowly peptonized; no indol; feeble diastatic action; nitrates not reduced; heavy viscid growth in Uschinsky's solution; acid from dextrose and galactose; no acid or gas from sucrose, lactose, maltose, glycerin; hydrogen sulphide and ammonia produced; optimum temperature 25°–30°C.; thermal death point 40°C.

Synonymy: *Phytomonas nectarophila* (Doidge) Bergey et al., 1930.

Symptoms: This organism causes blighting of flowers, peduncles, and young fruit. Infection takes place through the nectaries and sometimes stomata. Minute dark spots appear which increase rapidly in size, turn black and spread until the whole receptacle is involved. Sometimes the receptacle assumes a greenish brown water-soaked appearance before turning black. This blackening spreads to styles, ovary and sometimes to the flower stalk. Infected blossoms fall.

Host: *Pyrus communis.*

Geographical distribution: South Africa.

Literature:

1916. Doidge, E. M. A bacterial blight of pear blossom. The South African Fruit Grower **11:** 125, 1916.

1917. Doidge, E. M. A bacterial blight of pear blossoms occurring in South Africa. Ann. of Appl. Biol. **4:** 50–74, 1917.

1919. Doidge, E. M. The rôle of bacteria in plant diseases. So. African Journ. Sci. **16:** 65–92, 1919.

1930. Bergey's Manual of Determinative Bacteriology, p. 242, 1930. (3rd ed.)

Bacterium nigromaculans Takimoto, 1927

Motile by one to two polar flagella; 0.6–0.9 x 1.5–2.8μ; no spores; Gram negative; aerobic; agar colonies yellow, circular, slightly raised, smooth, glistening; growth in bouillon moderate with a yellow pellicle; gelatin slowly liquefied; no diastatic action; milk coagulated and casein digested; litmus reduced; good growth in Uschinsky's solution with pellicle; no growth in Cohn's; no gas; no acid from sucrose, glucose, lactose, mannit, glycerin; nitrates not reduced; ammonia produced; no indol; optimum temperature 27°–28°C.; maximum 33°C.; minimum 0°C.; thermal death point 50°C.

Symptoms: Lesions on the leaves first appear as dark green circular spots which gradually increase in size, become angular and bounded by the veins, and blackish brown in color or black. The centers of the spots fade, gradually becoming pale brown or lighter and thin, dry and transparent. Spots frequently coalesce to form large spots joined by linear lesions along the veins; linear black sunken lesions also occur on the petioles.

Host: *Arctium* sp.

Geographical distribution: Japan.

Literature:

1927. Takimoto, K. (Bacterial black spot of Burdock.) Journal Plant Protection (Tokyo) **14:** 519–523, 1927.

Bacterium (?) oncidii Peglion, 1899

Motile but flagella not stained; 1.3–1.5 x 0.8–1.0μ; whitish to slightly irridescent on agar; no diastatic action on starch; develops well in neutral or slightly acid media; gas formed in broth; acid and gas formed from sucrose.

Synonymy:

Bacillus oncidii (Peglion) Stevens, 1913.

See *Bacillus cypripedii* Hori.

Symptoms: This organism causes pale yellow, oily spots toward the apex or middle of the leaves which, spreading rapidly, attain a diameter of several centimeters. This disorganized tissue loses its turgor and becomes detached, leaving a blackened scar. If the leaf is attacked several times successively it may be entirely destroyed. The middle lamella is destroyed, the epidermis is entirely detached from the parenchyma, and the latter is entirely disentegrated. Under the epidermis is a turbid watery fluid which in late stages has the odor of putrefying tissue. Rot of orchid, bacteriosis.

Host: *Oncidium* sp.

Geographical distribution: Rome and Genoa, Italy.

Control: The disease was checked by removing plants from the greenhouse as soon as signs of the disease were discovered. Affected leaves were cut off below the spot and the cut surface painted with a solution of corrosive sublimate (1:100). Afterward the whole plant including the support to which it was attached was dipped for some minutes into a solution of copper sulphate (2:100). If after some time they showed no further signs of disease they were returned to the greenhouse.

Literature:

1899. Peglion, V. Bacteriosi delle foglie di *Oncidium* sp. Centralb. f. Bakt. 5: 33–37, 1899.

1902. Gateshead, J. B. Bacteriosis in orchids. Gardener's Chronicle **31**: 12, 1902. (It is probable, although not certain, that the bacterial rot of orchids described here is due to the organism isolated by Peglion.) Gateshead obtained his organism from a specimen of *Cattleya mendeli* with which he produced a rotting of bulbs of *Oncidium, Cattleya, Epidendrum, Miltonia, Coelogyne, Sophronitis, Dendrobium.* The middle lamella is destroyed. The organism is a short, motile rod which liquefies gelatin, destroys the middle lamella and has no power over starch. Among the inoculated species which Gateshead observed to rot without blackening was an *Oncidium.*

1912. Hori, S. A bacterial leaf disease of tropical orchids. Centralb. f. Bakt. 31: 85–92, 1912.

1913. Stevens, F. L. The fungi which cause plant disease, p. 46, 1913.

Bacterium oryzae (Uyeda and Ishiyama) Nak.?

Motile by one to two polar flagella; 0.5–0.8 x 1.0–2.0μ; no spores; no chains; aerobic; Gram negative; nutrient agar colonies round, smooth, glistening, wax yellow; milk cleared without coagulation; acid without gas from various carbohydrates; gelatin not liquefied; nitrates not reduced; no ammonia; no indol; hydrogen sulphide produced; optimum temperature 25°–30°C.; thermal death point 53°C.

Synonymy: *Pseudomonas oryzae* Uyeda and Ishiyama, 1922.

Symptoms: The disease occurs only on the leaves, appearing early in August when the stems and leaves begin to extend, and is at its worst during heading season. Small water-soaked spots appear on the margins of the leaves or along the midrib, gradually increasing in size to yellowish or whitish blotches or stripes, and giving the margins a wavy appearance. There is generally a bacterial exudate in the form of clouded droplets which harden into yellowish resinous granules. This exudate is a distinguishing characteristic of the disease. The vascular bundles become filled with bacteria and the plant dies. Infection takes place through wounds.

Host: *Oryza sativa.*

Geographical distribution: Japan.

Control: Improvement of soil conditions and the use of resistant varieties are promising means of control.

Literature:

1908. Nishida, Toji. Noji Zappo (Miscellaneous Agric. Report) No. 127, Oct., 1908. He claimed that the disease was closely related to the acidity of the soil.

1909. Takahashi, Masajiro. ["Report of white withering disease of rice."] In Ideta's (Handbook of the Plant Diseases of Japan) **1:** 894–898, 1909. (In Japanese.)

(1912)? Bokura, Umenojo "Teikoku Nogaku Kwaiho" (Journal of Agric. Society) **2:** No. 9, 10, 12 (1912)?. He names *Bacillus oryzae* Hori and Bokura as the cause of the disease but did not prove its pathogenicity by inoculation (from Ideta 1925).

1922. Ishiyama, Shinichi. Studien über die weissfleckenkrankheit der reispflanzen. (Studies of the white-spot disease of rice plants.) Mitteil. Kaiserl. Centralb. Landw. Versuchsta. Tokyo **45:** 233–261, 1922. The above reference is from Abstracts of Bacteriology **9:** 55, 1925 and from Japanese Journ. Bot. Trans. and Abstracts **1:** 21, 1922.

1923. Ishiyama, Shinichi. "Ine Yokobyo no Kenkyu" (Studies with reference to leaf withering disease of rice). In Report of Dept. of Agric. and Commerce, No. 15: 3, Feb., 1923.

1925. (White withering disease of rice leaves.) In Ideta's (Supplement to Handbook of the Plant Diseases of Japan) **1:** 63–64, 1925. A description of the organism and disease is given in this book.

1928. Hara, S. (A Thesaurus of Plant Diseases), p. 55, 1928. He gives Bact. oryzae (Uyeda and Ish.) Nak. Where and when the genus was changed has not been determined. (In Japanese.)

1928. Ishiyama, S. Bacterial leaf blight of the rice plant. Proc. Third Pan-Pacific Sci. Congr., Tokyo 1926, **2:** 2112, 1928. The writer states that "it was proved in 1927 by the writer that the disease is caused by a bacterial parasite."

Bacterium panaxi Takimoto, 1922

Motile by four to six polar flagella; 0.5 x 1.3–1.5μ; chains; pseudocapsules; Gram negative; facultative anaerobe; dirty white on agar; green fluorescent on

alkaline media; gelatin slightly liquefied; milk coagulated; no gas; thermal death point 50°–52°C.

Symptoms: This organism causes an amber colored rot of roots and stems and gives them a water-soaked appearance; in advanced stages only vascular fibres of the host remain.

Host: *Panax quinquefolium.*

Geographical distribution: Japan, Korea.

Literature:

1923. Nakata, K., and S. Takimoto. Studies on ginseng disease in Korea. Bul. Agr. Exp. Sta. Chosen No. 5: 1–81, 1922. (In Japanese, new species and description in English.) English abstract in Japanese Journ. Bot. 1: 43–44, 1923. Nothing is said in the abstract about inoculations.

Bacterium panici Elliott, 1923

Motile by one to three polar flagella; average measurements 0.69 x 1.66μ; capsules; no spores; chains; aerobic; Gram negative; not acid fast; beef peptone agar colonies round, white, smooth, glistening, raised, margin at first entire, later undulate with strong odor; gelatin slowly liquefied; milk cleared without coagulation; litmus in milk reduced; ammonia and hydrogen sulphide produced; no indol; no gas; nitrates reduced; diastatic action moderate; growth slight in Cohn's solution, moderate in Uschinsky's, heaviest in Fermi's; heavy clouding in beef bouillon, thin pellicle, and strong odor of decay; optimum temperature 33–34°C.; maximum 45°C.; minimum 5.5°C.; thermal death point about 51°C.

Synonymy:

Pseudomonas panici (Elliott) Stapp, 1928.

Phytomonas panici (Elliott) Bergey et al., 1930.

Symptoms: This organism causes narrow brown, water-soaked streaks on leaves, sheaths and culms. When the streaks coalesce the tissue is brown and translucent. Abundant exudate dries to form thin glistening scales along the streaks. Similar lesions occur on the peduncles and pedicles of the panicle. In some cases the whole upper part of the plant including the head is killed. The infected tissues may be brown and dry or may remain soft where partly enclosed by lower leaves and sheaths. In such case new shoots come out at the base.

Host: *Panicum miliaceum.*

Geographical distribution: Madison, Wisconsin; Brookings, South Dakota.

Literature:

1923. Elliott, Charlotte. A bacterial stripe disease of proso millet. Journ. Agr. Res. 26: 151–159, 1923.

1925. Brookes, R. St. John, K. Nain, and M. Rhodes. The investigation of phytopathogenic bacteria by serological and biochemical methods. Journ. Path. and Bakt. 28: 203–209, 1925. See *Bacillus carotovorus.*

1928. Stapp, C. Schizomycetes (Spaltpilze oder Bakterien). In Sorauer's Handbuch der Pflanzenkrankheiten. 2 (fünfte auflage): 27–28, 1928.

1930. Bergey's Manual of Determinative Bacteriology, p. 243, 1930. (3rd ed.)

Bacterium papavericola Bryan and McWhorter, 1930

Motile by a single polar flagellum; 0.6–0.7 x 1.0–1.7μ; chains; capsules; no spores; Gram negative; not acid fast; aerobic; agar colonies mustard yellow, smooth, convex, round, translucent, margins entire; clouding in bouillon prompt with formation of yellow rim and pellicle; strong diastatic action; gelatin and blood serum liquefied; acid without gas from dextrose, sucrose, galactose, levulose, lactose, maltose, glycerin, mannit; nitrates reduced; milk coagulated and peptonized; ammonia and hydrogen sulphide produced; no indol; optimum temperature 25°–30°C.; maximum temperature about 35°C.; thermal death point 52°C.

Symptoms: Young infections are first evident as minute water-soaked areas which soon darken to intense black spots bounded by a hyaline or water-soaked ring. Scattered spots are circular, clearly defined, often zonate and may attain a diameter of 3–4 millimeters. Tissue between the spots turns yellow and finally brown. A slimy bacterial exudate is noticeable at times. Infection takes place through the stomata and sometimes enters the veins producing systemic infection. Stem lesions are intensely black, elongated, and may girdle the stems and cause young plants to fall over. All floral parts are susceptible. Sepals may be partially or entirely blackened and when the infection passes through to the petals floral development ceases. Spots on the pods are black and conspicuous.

Hosts: *Papaver rhoeas, Papaver orientale.*

Geographical distribution: Virginia, Connecticut.

Literature:

1909. Clinton, G. P. Report of the Botanist. Connecticut Agr. Exp. Sta., Bien. Rept. 1907–1908: 870, 1909.

1930. Bryan, Mary K., and Frank P. McWhorter. Bacterial blight of poppy caused by *Bacterium papavericola*, sp. nov. Journ. Agr. Res. 40: 1–9, 1930.

Bacterium papulans (Rose) n. comb.

Motile by one to six bipolar flagella; 0.6 x 0.9–2.3μ; no spores; no capsules; Gram negative; not acid fast; aerobic; growth on plain agar filiform, slightly convex, whitish; no gas from dextrose, sucrose, maltose, lactose, glycerin, mannit; gelatin liquefied; milk coagulated and cleared; acid from dextrose and sucrose; nitrates not reduced; no indol; ammonia produced; green fluorescent in dextrose agar, glycerin agar and Uschinsky's solution; no growth in Cohn's; Optimum temperature 25°–28°C.; no growth at 37°C.

Synonymy:

Pseudomonas papulans Rose, 1917.

Phytomonas papulans (Rose) Bergey et al., 1930.

Symptoms: This organism causes small, dark brown blisters on fruit and a rough bark canker on the limbs. The first sign of this disease is a slight darkening around the lenticel followed by the formation of whitish to pale brown blisters 0.2–0.5 mm. in diameter. The epidermis over the blister turns dark brown to black and dies. It may crack loose or the lesion may grow to form irregularly lobed shallow blisters. Usually lesions occur on the lower half of

the apple around the blossom end but in some varieties they may occur over any part of the surface except the upper fifth. These spots are surrounded by narrow greenish or red rings depending upon the variety. In the quiescent stage patches of roughened scaly bark occur on the limbs varying in size from a few square centimeters to those covering the side of a limb for a meter or more. They are usually on the north side of the limb and bordered by a pimpled lumpy ridge slightly more brown or reddish brown than the healthy bark. In the active stage of early spring the outer bark sloughs off. Narrow cracks form outside the pimply ridge. The bark inside the cracks for a depth of 2 mm. drys and curls, revealing a spongy layer underneath. The dry, curled bark breaks off readily, sometimes only the epidermis is loosened.

Host: *Malus sylvestris.*

Geographical distribution: Missouri.

Literature:

1912. Hewitt, J. E. An unknown apple disease. Arkansas Agr. Exp. Sta. Bul. 122: 481–491, 1912.
1914. Rose, D. H. Report of the pathologist. Missouri State Fruit Exp. Sta. Rept. 1913–14 (Bul. 24): 30, 1914.
1916. Rose, D. H. Blister spot of apples. Phytopath. **6**: 110, 1916. (Abstract.)
1917. Rose, D. H. Blister spot of apples and its relation to a disease of apple bark. Phytopath. **7**: 198–208, 1917.
1930. Bergey's Manual of Determinative Bacteriology, p. 243, 1930. (3rd ed.)

Bacterium pelargoni Brown, 1923

One polar flagellum; 0.67 x 1.02μ; chains; capsules; no spores; aerobic; Gram negative; not acid fast; beef agar colonies cream colored, round, glistening, with delicate internal markings; gelatin slowly liquefied; litmus reduced; ammonia, indol (slight) and hydrogen sulphide produced; nitrates not reduced; grows weakly in Uschinsky's and Fermi's solutions and not at all in Cohn's; milk curdled and slowly peptonized; feeble diastatic action; no gas; optimum temperature 27°C.; maximum 35°C.; minimum 1°C.; thermal death point between 51° and 51.5°C.

Synonymy:

Pseudomonas pelargoni (Brown) Stapp, 1928.

Phytomonas pelargoni (Brown) Bergey et al., 1930.

Symptoms: This organism causes irregular to circular brown leaf spots. Numerous minute water-soaked spots form on the under surfaces of the leaves. These increase in size and become sunken on the under surface and finally on the upper also and at this stage the tissues collapse and become brown. Finally many spots coalesce and the last stage is a complete yellowing, browning and shriveling of the leaf. The petioles remain rigid and in the main unspotted. This is primarily a disease of the parenchyma and it is only when the disease is far advanced that the vascular system is invaded. There are great differences in varietal susceptibility.

Host: *Pelargonium* sp.

Geographical distribution: Massachusetts, New Jersey, Maryland, Virginia, District of Columbia, general through eastern United States.

Control: Spotted leaves should be destroyed and cuttings selected from sound plants. Susceptible varieties should be discarded: Ernest South is very susceptible; Admiral Dewey and Harry French are less susceptible; Countess de Baum is resistant; James Vick is very resistant. Care should be exercised in regulating the temperature, air and moisture conditions of the greenhouse and in giving plenty of space to plants out of doors.

Literature:

1898. Stone, G. E., and R. E. Smith. A disease of the cultivated geranium. 10th Ann. Rept. Massachusetts Agr. Exp. Sta. for 1897: 67, 1898. Bacteria were found in spots on geranium leaves. This is the first published report of the disease.

1907. Kirk, T. W. Leaf spot of Pelargonium. Ann. Rept. New Zealand Dept. Agric. 15: 150–152, 1907. He states that he was unable to find any fungus mycellium or spores. This is perhaps the bacterial disease in question.

1911. Smith, E. F. Bacteria in relation to plant diseases 2: 62, 1911.

1923. Brown, N. A. Bacterial leaf spot of geranium in the eastern United States. Journ. Agr. Res. 23: 361–372, 1923. She compares the organism with *Bact. erodii* Lewis and concludes they are different.

1925. Brookes, R. St. John, K. Nain and M. Rhodes. The investigation of phytopathogenic bacteria by serological and biochemical methods. Journ. Path. and Bakt. 28: 203–209, 1925. See *Bacillus carotovorus*.

1928. Stapp, C. Schizomycetes (Spaltpilze oder Bakterien). In Sorauer's handbuch der Pflanzenkrankheiten 2 (fünfte auflage): 181–182, 1928.

1930. Bergey's Manual of Determinative Bacteriology, p. 241, 1930. (3rd. ed.)

Bacterium petasites Takimoto, 1927

Motile by one to two polar flagella; 0.8–1.0 x 1.1–1.7μ; no spores; no capsules; Gram negative; facultative anaerobe; white on agar; gelatin not liquefied; milk curdled; indol not produced; gas formed; nitrates reduced; slight diastatic action; thermal death point 55°–56°C.

Symptoms: The leaves show circular brown spots which gradually become larger and irregularly elongated and finally turn black. On the under surface lesions are at first dull green or dark purplish brown, later dark brown.

Host: *Petasites japonicus.*

Geographical distribution: Japan.

Literature:

1927. Takimoto, S. Bacterial disease of Petasites. Ann. Phytopath. Soc. Japan 2: No. 1, 53–56, 1927. Abstract also in Ann. Phytopath. Soc. Japan 3: No. 4, 113–114, 1927, and Ann. Appl. Mycol. 7: 31–32, 1928.

Bacterium phaseoli E. F. Smith, 1905

Single polar flagellum; 0.3–0.8 x 0.5–3.0μ; capsules; no spores; aerobic; Gram negative; not acid fast; beef agar colonies small, circular, smooth, pale yellow,

becoming deep with age, entire margined, oftén pale ringed, sometimes slightly viscid; beef bouillon lightly clouded, with yellowish rim in 3–4 weeks and partial to complete pellicle, viscid yellow precipitate; gelatin and blood serum liquefied; milk curdled by means of a lab ferment and casein sometimes peptonized without apparent curdling; litmus milk blued and slowly reduced; methylene blue promptly reduced; copious yellow growth on potato cylinders; feeble growth in Cohn's and Uschinsky's solutions; thermal death point about 50°C.; no indol; hydrogen sulphide produced; ammonia produced; strong diastatic action; nitrates not reduced; no gas; acid from dextrose, lactose, sucrose, glycerin, maltose, levulose, galactose in peptone free media; resistant to drying.

Synonymy:

Bacillus phaseoli E. F. Smith, 1898.
Pseudomonas phaseoli (E. F. Smith) E. F. Smith, 1901.
Phytomonas phaseoli (E. F. Smith) Bergey et al., 1923.

Symptoms: This is chiefly a spot disease of the parenchyma but may also invade the vessels and cause dwarfing and wilting of plants. Leaf lesions first appear as small translucent dots which later become irregular sunken reddish or brownish spots with yellow borders involving a large part of the leaf. If leaves are attacked in early stages of growth they may become twisted and distorted and in severe cases shrivel and fall off. Longitudinal reddish streaks may completely girdle the stem and cause the plant to break over at this point. Spots on the pods first appear about the stomata as water-soaked green circular dots. These enlarge to irregular dry sunken areas often brick red or brownish in color and frequently covered with yellowish white crusts of exudate. Seeds may become infected from the pods. Bacterial bean blight.

Hosts: *Dolichos lablab*, *Phaseolus aconitifolius*, *Phaseolus acutifolius latifolius*, *Phaseolus angularis*, *Phaseolus aureus*, *Phaseolus lunatus*, *Phaseolus lunatus macrocarpus*, *Phaseolus coccineus* (*multiflorus*), *Phaseolus mungo*, *Phaseolus vulgaris*, *Soja max*, *Stizolobium deeringeanum*, *Strophostyles helvola*, *Vigna sinensis*.

Geographical distribution: General throughout the United States; Ontario, Canada, Austria; Norway; south Russia; Transcaucasia; China; Japan; Philippines; South Africa. The organism has been isolated from seed from Germany. The disease also probably occurs in France.

Control: Plants from diseased fields should be burned. Where possible, only seed from disease-free fields should be planted as this is a seed-borne disease. The use of 2–3 year old seed, treatment for 20 minutes with 1:1,000 mercuric chloride before sowing, or soaking for ten minutes in water at 45°C. all tend to reduce the amount of initial infection but the development of resistant varieties is the most promising means of control. Out of 663 varieties and strains of beans tested, Rands and Brotherton (1925) found 65 varieties which showed decided resistance. No high degree of resistance was found in any variety of *Phaseolus vulgaris* tested. Several foreign varieties showed more resistance than American varieties. The trailing wild bean, *Strophostyles helvola*, has been shown to be a host (Gardner,1924) and should be destroyed. Gloyer found that late planting reduces susceptibilty to blight.

Literature:

1892. Beach, S. A. Blight of common beans. Blight of lima beans. New York Agric. Exp. Sta., Geneva, Bul. 48: 329–331, 1892. This is the first account of the bacterial disease of beans due to the organism subsequently named *Bacillus phaseoli*. The organism was isolated from poured plates and infections were secured on pods inoculated from pure cultures.

1893. Halsted, B. D. A Bacterium of *Phaseolus*. 13th Ann. Rept. New Jersey State Agr. Exp. Sta. for 1892: 283–285, 1893. He describes a bacterial disease of pods and seed and his direct infection experiments were successful. He says the disease was known as early as 1886. In subsequent years Halsted made many field experiments looking toward the prevention of the disease.

1897. Smith, E. F. Description of *Bacillus phaseoli* n. sp. Bot. Gazette 24: 192, 1897. (Abstract.)

1898. Smith, E. F. Description of *Bacillus phaseoli* n. sp. with some remarks on related species. Proc. Amer. Assoc. Adv. Sci., 46th Meeting 1897: 288–290, 1898. The writer first produced this disease from pure cultures in 1896.

1899. Delacroix G. La Graisse, maladie bacterienne des Haricots. Compt. Rend. Acad. Sci. (Paris) 129: 656–659, 1899. He describes the water-soaked (greasy) spots on pods, leaves and stems, and the yellow exudate and says he thinks the causal organism is Smith's *Bacillus phaseoli*.

1899. Sturgis, W. C. A bacterial blight of lima beans. 22nd Ann. Rept. Connecticut Agric. Exp. Sta. for 1898: 262–263, 1899.

1901. Halsted, B. D. Bean diseases and their remedies. Bacteriosis of bean. New Jersey Agric. Exp. Sta. Bul. 151: 11–18, 1901.

1901. Smith, E. F. The cultural characters of *Pseudomonas hyacinthi*, *Ps. campestris*, *Ps. phaseoli*, and *Ps. stewarti*—four one flagellate yellow bacteria parasitic on plants. U. S. Dept. Agric., Div. Veg. Phys. and Path., Bul. 28: 1–153, 1901.

1901. Speschnew, N. N. Beiträge zur Kenntnis der Pilzflora des Kaukasus III. Fungi parasitici transcaucasici novi aut minus cogniti. Trudy Tifl. Bot. Sad. 5: 1–14, 1901. Russian with Latin diagnosis.

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1905. Smith, E. F. Bacteria in relation to plant diseases 1: 72, 1905.

1906. Whetzel, H. H. Some diseases of beans. Cornell Univ. Agric. Exp. Sta. Bul. 239: 210–212, 1906. This is a brief early account of the disease.

1908. Fulton, H. R. Diseases of pepper and beans. Louisiana Agr. Exp. Sta. Bul. 101: 13–16, 1908.

1909. Sackett, W. G. Some bacterial diseases of plants. Colorado Agr. Exp. Sta. Bul. 138: 21–22, 1909.

1911. McCready, S. B. Bean diseases. Ann. Rpt. Ontario Agr. Col. and Exp. Farm, 1910, 36: 46, 1911. Describes *Bact. phaseoli* and means for its control.

1913. Edgerton, C. W., and C. C. Moreland. The bean blight and preservation and treatment of bean seed. Louisiana Agr. Exp. Stat. Bul. 139: 1–43, 1913.

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1914. Muncie, J. H. Two Michigan bean diseases. Michigan Agr. Exp. Sta., Special Bul. 68: 426–428, 1914.

1916. Jones, D. H. Some bacterial diseases of vegetables found in Ontario. Ontario Dept. Agr. Bul. 240: 23–24, 1916.

1916. Linsbauer, L. Tatigkeitsbericht des botan. Versuchslaboratoriums und des Laboratoriums für Pflanzenkrankheiten der K. K. höheren. Lehranstalt für Wein- und Obstbau in Klosterneuburg für 1915/16: 6, 1916. He reports the disease from Austria.

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1917. Muncie, J. H. A girdling of bean stems caused by *Bact. phaseoli*. Science (n.s.) **46**: 88–89, 1917.

1917. Muncie, J. H. Experiments on the control of bean anthracnose and bean blight. Michigan Agr. Exp. Sta., Tech. Bul. 38: 3–50, 1917.

1919. Doidge, E. M. The bacterial blight of beans. South African Journ. Sci. 15: 503–505, 1919.

1919. Doidge, E. M. The rôle of bacteria in plant diseases. So. African Journ. Sci. 16: 65–92, 1919.

1919. Rapp, C. W. Aged bean seed, a control for bacterial blight of beans. Science 50: 568, 1919.

1919. Reinking, O. Diseases of economic plants in southern China. The Philippine Agriculturist 8: 110–111, 1919.

1919. Reinking, O. Philippine plant diseases. Phytopath. 9: 131, 1919. *Pseudomonas phaseoli* was common and destructive on *Phaseolus vulgaris*, *Phaseolus lunatus*.

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1920. Smith, E. F. An introduction to bacterial diseases of plants, pp. 280–299, 1920.

1921. Burkholder, W. H. The bacterial blight of the bean: a systemic disease. Phytopath. 11: 61–69, 1921.

1922. Gloyer, W. O. Bacterial blight of beans under field conditions. Abstracts of Bact. 6: 40, 1922.

1922. Jørstad, I. Beretning om plantesykdommer i land-og havebruket 1920–1921: C35, 1922. I. Landbruksvekster og grønnsaker. *Bacterium phaseoli* is reported on beans from Norway.

1923. Bergey's Manual of Determinative Bacteriolgy, pp. 177–178, 1923.

1923. Paine S. G., and M. S. Lacey. Studies in bacteriosis X. "The use of serum-agglutination in the diagnosis of plant parasites." Ann. Appl. Biol. 10: 204–209, 1923. *Bacillus lathyri* and *Pseudo-*

monas phaseoli are to be regarded as distinct species. Although they showed distinctive cultural characters they gave some evidence of cross agglutination.

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1924. Gardner, M. W. A native wild host for bacterial blight of bean. Phytopathology **14**: 341, 1924.

1924. Division of Botany. 42nd Ann. Rpt. New York State Sta. Rpt. for year ending June 30, 1923: 33, 1924.

1924. Gardner, M. W. Indiana Plant Diseases 1921. Proc. Indiana Acad. Sci. **33**: 171–172, 1924. He reports *Ps. phaseoli* on *Phaseolus mungo* (Urd bean); *Phaseolus aureus* (Mung bean); *Dolichos lablab* (Hyacinth bean); *Phaseolus multiflorus* (White Dutch Case Knifebean.

1924. Gardner, M. W. A native weed host for bacterial blight of bean. Phytopath. **14**: 341, 1924. Cross inoculations on bean proved that *Strophostyles helvola* (L) Britton (trailing wild bean) is a host for *Bact. phaseoli*.

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1924. Hedges, F. A study of bacterial pustule of soybean and a comparison of *Bacterium phaseoli sojense* Hedges with *Bacterium phaseoli* E. F. Smith. Journ. Agr. Res. **29**: 229–251, 1924.

1924. Wolf, F. A. Bacterial pustule of soybean. Journ. Agr. Res. **29**: 57–68, 1924.

1925. Brookes, R. St. John, K. Nain, and M. Rhodes. The investigation of phytopathogenic bacteria by serological and biochemical methods. Journ. Path. and Bakt. **28**: 203–209, 1925. See *Bacillus carotovorus*.

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1925. Rands, R. D., and W. Brotherton. Bean varietal tests for disease resistance. Journ. Agr. Res. **31**: 101–154, 1925.

1926. Hedges, F. Bacterial wilt of beans (*Bacterium flaccumfaciens* Hedges) including comparisons with *Bacterium phaseoli*. Phytopathology **16**: 1–21, 1926.

1926. Sackett, W. G. Report of Bacteriologist. 39th Ann. Rpt. Colorado Agr. Exp. Sta. for 1926: 18, 1926. A very appreciable reduction in the number of diseased plants resulted from the use of 2 year old seed as compared with one year old stock.

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1927. Agglutination tests show that the biological specificity displayed by these organisms in their host relations is associated with serological specificity.

1927. Link, G. K. K., and C. G. Sharp. Serological differentiation of *Bacterium campestre* from *Bact. phaseoli*, *Bact. phaseoli sojense*, and *Bact. flaccumfaciens*. Phytopath. 17: 53–54, 1927. (Abstract.) *Bact. campestre* can be differentiated serologically from the other two.

1927. Sackett, W. G. Report of Bacteriologist. 40th Ann. Rept. Colorado Agr. Exp. Sta. for 1927: 22–23, 1927. *Bacterium phaseoli* caused heavy damage. Use of 3 year old seed considerably reduced the infection.

1927. Sharp, C. G. Virulence, serological and other physiological studies of *Bacterium flaccumfaciens*, *Bact. phaseoli* and *Bact. phaseoli sojense*. Bot. Gaz. 83: 113–144, 1927.

1928. Hedges, Florence. Bacterial diseases of beans in some western commercial seed growing and canning areas and southern trucking sections in 1927 and 1928. U. S. Dept. Agric., B. P. I., The Plant Disease Reporter 12: 121–122, 1928. *Bact. phaseoli* caused extensive losses through stem-girdling in Utah, fully 3/4 of the plants being broken over in some fields near Logan.

1928. Link, Geo. K. K., and Adeline DeS. Link. Further agglutination tests with bacterial plant pathogens. I. *Bacterium campestre-Bact. phaseoli* group; *Bact. medicaginis* var. *phaseolicola; Bact. tumefaciens*. Bot. Gaz. 85: 178–197, 1928.

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1928. Martin, W. H. Report of the Department of Plant Pathology. Forty-eighth Ann. Rept. New Jersey Agr. Exp. Sta. for year ending June 30, 1927: 207, 1928. Bacterial blight of beans was more severe than usual.

1929. McCulloch, L. A bacterial leaf spot of horse-radish caused by *Bacterium campestre* var. *armoraciae* n. var. Journ. Agr. Res. 38: 269–285, 1929. Tabular comparison of *Bacterium campestre armoraciae*, *Bacterium campestre*, *Bacterium phaseoli*.

1929. Patel, M. K. Viability of certain plant pathogens in soils. Phytopath. 19: 295–300, 1929.

1929. Zaumeyer, W. J. Seed infection by *Bacterium phaseoli*. Phytopath. 19: 96, 1929. Seed infection takes place through the vascular system and the micropyle.

Bacterium phaseoli var. sojense Hedges, 1924

Motile by one to two polar flagella; 0.5–0.9 x 1.4–2.3μ; chains; no capsules; no spores; aerobic; Gram negative; beef agar colonies small, circular or nearly circular, smooth, pale yellow, entire margined, becoming deeper yellow with age and then often pale ringed, non-viscid to slightly viscid and with internal convolutions; gelatin promptly liquefied; blood serum liquefied; no gas; acid from dex-

trose, and lactose on peptone free media (from unpublished results of Hedges); nitrates not reduced; strong diastatic action; milk curdled by means of a lab ferment and peptonized; growth feeble in Cohn's and Uschinsky's solutions; moderate clouding in beef bouillon and in 3–4 weeks a partial or complete pellicle which may be thin or heavy; ammonia produced; no indol; growth on potato cylinders copious consuming practically all the starch and filling the water about the cylinder with a solid yellow mass of slime; thermal death point about 50°C.

Symptoms: The first signs of the disease are small, inconspicuous pale green or reddish brown spots slightly elevated in the center. These pustules may be confined to one surface or appear on both sides of the leaf. They finally rupture the epidermis and, as the spot grows older, usually collapse, shrivel or slough off. These lesions are never water-soaked. They become angular reddish-brown spots which may remain small and inconspicuous or fuse to form large irregular mottled brown areas involving a large part of the leaf. Parts of these spots may fall out leaving the leaf ragged. Yellow borders may surround the spots. Brown slightly raised spots may occur on the pods.

Hosts: *Phaseolus lunatus macrocarpus, Phaseolus vulgaris, Soja max.*

Geographical distribution: Delaware, Maryland, Virginia, North Carolina, South Carolina, Louisiana, Texas, Arkansas, Kansas, Canada (western), South Dakota.

Control: Means of control have not been worked out, but the following varietal differences in susceptibility have been recorded. Midwest is a susceptible variety. Wilson Fine, Buckshot, Mandarin and Biloxi are highly resistant.

Literature:

1898. Smith, E. F. Description of *Bacillus phaseoli* n. sp. with some remarks on related species. Proc. Amer. Assoc. Adv. Sci. **46**: 288–290, 1898.

1901. Smith, E. F. The cultural characters of *Pseudomonas hyacinthi, Ps. campestris, Ps. phaseoli,* and *Ps. stewarti,* four one-flagellate yellow bacteria parasitic on plants. U. S. Dept. Agr., Div. Veg. Phys. and Path. Bul. 28: 1–153, 1901.

1904. Smith, E. F. Bacterial leaf spot diseases. Science **19**: 417–418, 1904. This is the first mention of the disease in literature.

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1924. Hedges, F. A study of bacterial pustule of soybean, and a comparison of *Bacterium phaseoli sojense* Hedges with *Bacterium phaseoli* E. F. Smith. Journ. Agr. Res. **29**: 229–251, 1924.

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1925. Brookes, R. St. John, K. Nain and M. Rhodes. The investigation of phytopathogenic bacteria by serological and biochemical methods. Journ. Path. and Bakt. **28**: 203–209, 1925. See *Bacillus carotovorus.*

1925. Adams, J. F. Department of Plant Pathology. Ann. Rept. Delaware Agr. Exp. Sta. for the fiscal year ending June 30, 1924: 27, 1925. *Bacterium phaseoli sojense* is reported for the first time from Delaware.
1925. Bisby, G. R. Forage Crop Diseases. Western Canadian Soc. Agron. Proc. **5**: 62, 1925.
1927. Link, G. K. K., and K. L. Hull. Smoothness and roughness and spontaneous agglutination of *Bacterium citri*, *Bact. medicaginis* var. *phaseolicola*, *Bact. phaseoli sojense* and *Bact. tumefaciens*. Bot. Gaz. **73**: 412–419, 1927.
1927. Link, G. K. K., and C. G. Sharp. Serological differentiation of *Bacterium campestre* from *Bact. phaseoli*, *Bact. phaseoli sojense* and *Bact. flaccumfaciens*. Phytopath. **17**: 53–54, 1927. (Abstract.)
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1927. Sharp, C. G. Virulence, serological and other physiological studies of *Bacterium flaccumfaciens*, *Bacterium phaseoli* and *Bacterium phaseoli sojense*. Bot. Gaz. **83**: 113–144, 1927.
1928. Link, Geo. K. K., and A. DeS. Link. Further agglutination tests with bacterial plant pathogens. I. *Bacterium campestre-Bact. phaseoli* group; *Bact. medicaginis* var. *phaseolicola; Bact. tumefaciens*. Bot. Gaz. **85**: 178–197, 1928.
1929. Rane, L. Virulence, electrophoresis, and conversion characteristics of *Bact. phaseoli sojense*, S. and R. Proc. Soc. Exper. Biol. and Med. **26**: 299–301, 1929.

Bacterium pisi (Sackett) E. F. Smith, 1920

Motile by one polar flagellum; 0.58–0.82 x 1.11–3.28μ; no spores; no capsules; Gram negative; not acid fast; aerobic; agar colonies grayish white, round, slightly raised, with undulate margins; yellow on potato; yellowish green on starch jelly; gelatin liquefied; milk coagulated by lab ferment and slowly peptonized; no diastatic action; acid from dextrose, galactose, sucrose; no gas; ammonia produced; nitrates not reduced; no indol; no hydrogen sulphide; grows in Fermi's solution; does not grow in Uschinsky's and Cohn's; thermal death point 50°C.

Synonymy:

Pseudomonas pisi Sackett, 1916.

Phytomonas pisi (Sackett) Bergey et al., 1923.

Symptoms: This organism enters through stomata or wounds causing watery olive-green to olive-brown lesions on stems, petioles, leaves, stipules and pods. Leaf spots first appear as dark green water-soaked dots, which enlarge, become

darker green and as the leaves dry out, a russet brown. Stem lesions are more linear—sometimes the whole stem turns dark green and finally brown. Infection spreads to the petioles which wilt and allow the leaves to droop. Veins and midribs of leaves and stipules may become water-soaked. Infection may spread through the peduncles, killing the flowers and causing young pods to shrivel and decay. Older pods show water-soaked lesions and cracking. Badly infected pods contain seeds covered with bacterial slime which may remain on the surface or may penetrate the seed coat. Exudate may form short cirri or spread out into thin bacterial films over the lesions. Bacteria spread through the intercellular spaces may break down the cell walls and produce large cavities. If they enter the vascular bundles they cause wilting of leaflets and sometimes of the whole plant. If vines become diseased when small they are usually killed outright.

Hosts: *Dolichos lablab, Lathyrus odoratus, Lathyrus latifolius, Pisum sativum, Pisum sativum arvense, Vigna* sp.

Geographical distribution: General throughout central and eastern United States; Colorado, Utah, Idaho, Wyoming, Montana; possibly in England.

Control: Methods of cultivation which reduce mechanical injuries to a minimum will help keep down infection. The most promising means of control is the use of resistant varieties. Adams (1925) found Advancer resistant and Rice 330 susceptible. The disease is seed borne.

Literature:

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1921. Jennison, H. M. Observations upon the bacterial blight of field and garden peas in Montana. Phytopath. **11**: 104, 1921.

1923. Bergey's Manual of Determinative Bacteriology, pp. 181–182, 1923.

1924. Burger, O. F. Report of Plant Pathologist. Rept. Florida Agr. Exp. Sta. for year ending June 30, 1924; 108R, 1924.

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1924. U. S. Dept. Agr., B. P. I., Plant Disease Reporter **8**: 12–14, 1924.

1925. Adams, J. F. Diseases of canning peas. Ann. Rept. Delaware Agr. Exp. Sta. for year ending June 30, 1924 (Bul. 139): 26, 1925.

1925. Gardner, M. W. Indiana plant diseases 1923. Proc. Indiana Acad. Sci. **34**: 304–305, 1925.

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1926. Ludwig, C. A. *Pseudomonas* (*Phytomonas*) *pisi* Sackett, the cause of pod spot of garden peas. Phytopath. **16**: 75, 1926. (Abstract.)

1926. Ludwig, C. A. *Pseudomonas* (*Phytomonas*) *pisi* Sackett, the cause of pod spot of garden peas. Phytopath. **16**: 177–183, 1926.

1927. Skoric, V. Bacterial blight of pea: overwintering, dissemination, and pathological histology. Phytopath. **17**: 611–627, 1927.

1929. Linford, M. B. Pea diseases in the United States in 1928. U. S. Dept. Agr., B. P. I., Plant Disease Reporter, Supplement 67: 2–3, 1929. The heaviest infection was in one field in Illinois.

Since the disease is seed borne its presence in the seed producing states of Idaho and Montana is of interest.

1929. Ogilvie, L. Economic mycology. Ann. Rept. Agric. and Hort. Res. Sta., Long Ashton, Bristol, for 1928: 191, 1929. Field peas were attacked by a bacterial blight similar to that in the United States.

1929. Riker, A. J. Studies on the influence of environment on infection by certain bacterial plant parasites. Phytopath. 19: 96, 1929.

Bacterium proteamaculans (Paine and Stansfield) n. comb.

Polar flagellate; 0.6–0.8 x 0.8–1.6μ; no capsules; Gram positive; growth on agar raised, wet, dirty white to yellow; acid and gas from glucose, sucrose, mannit; no acid or gas from lactose; nitrates reduced; slight diastatic action; milk curdled; growth on potato pale yellow; grows in Uschinsky's solution; thermal death point 51°–53°C.

Synonymy:

Pseudomonas proteamaculans Paine and Stansfield, 1919.

Phytomonas proteamaculans (Paine and Stansfield) Bergey et al., 1930.

Symptoms: Dome-shaped blisters of a reddish-brown color and 1–3 mm. in diameter occur mainly on upper leaf surfaces. On young leaves red or reddish brown depressed areas surrounded by zones of bright vermillion are formed. These have diameters up to 5 or 6 millimeters and may coalesce to form larger patches. By transmitted light there is a clear translucent halo 1–2 millimeters in diameter around each spot. Internally the cells are completely disorganized and displaced by a yellow or brown gum-like mass. Bacteria enter through the stomata and development of wound cork prevents extensive spreading.

Host: *Protea cynaroides.*

Geographical distribution: Kew Gardens, London, England.

Control: The authors suggest as a means of control spraying the plants with a solution of mercuric chloride (1:10,000) or a formalin solution (1:400).

Literature:

1919. Paine, S. G., and H. Stansfield. Studies in bacteriosis III. A bacterial leaf spot disease of *Protea cynaroides*, exhibiting a host reaction of possibly bacteriolytic nature. Ann. Appl. Biol. **6**: 27–39, 1919.

1921. Paine, S. G., and E. M. Berridge. Studies in bacteriosis V. Further investigation of a suggested bacteriolytic action in *Protea cynaroides* affected with the leaf-spot disease. Ann. Appl. Biol. 8: 20–26, 1921. "The production by the cells of *Protea cynaroides* of a bacteriolysin against the organism which produces a leaf-spot disease, suggested in a former paper, has not been confirmed." The host prevents the spread of the organism by the development of wound cork.

1925. Brookes, R. St. John, K. Nain and M. Rhodes. The investigation of phytopathogenic bacteria by serological and biochemical methods. Journ. Path. & Bact. 28: 203–209, 1925. See *Bacillus carotovorus*.

1930. Bergey's Manual of Determinative Bacteriology, p. 240, 1930. (3rd ed.)

Bacterium pruni (E. F. Smith) E. F. Smith, 1905

Motile by one to 6 polar flagella; 0.4–0.6 x 1.6–1.8μ; capsules; short chains; Gram negative; not acid fast; aerobic; yellow on culture media; gelatin slowly liquefied; slight diastatic action; milk curdled and peptonized; no gas; acid from sucrose, dextrose, lactose, glycerin; nitrates reduced; indol produced; grows in Cohn's solution; litmus reduced; thermal death point about 51°C.

Synonymy:

Pseudomonas pruni E. F. Smith, 1903.

Phytomonas pruni (E. F. Smith) Bergey et al., 1923.

See *Bacterium cerasus wraggi* (Sackett).

Symptoms: This organism causes injury to fruit, leaves and twigs. The earliest visible stage of the disease on all parts consists of minute, translucent areas centering in stomata. On the fruit these spots enlarge rather slowly, becoming brown to black. The tissue in the center of the spot collapses and the skin sinks in forming a gradually expanding saucer-shaped depression which may show small rounded masses of yellow exudate. As the fruits increase in size they crack open through these spots. Several cracks may coalesce. Formation of a corky layer protects the flesh of the fruit but the ragged cracked surface makes the fruit unfit for the market. However, serious losses from fruit injury are unusual. The disease occurs on the branches in the form of numerous shallow cankers. These first appear as grayish water-soaked spots which later become darker and sunken. A number of infections may coalesce forming large cankers and gum may exude. Twigs and branches are seldom killed but it is in the twigs that the organism overwinters and these lesions act as sources of leaf infection in the spring. Injury to the leaves is the most serious phase of the disease, sometimes amounting to complete defoliation and often to 25–50 per cent of defoliation. Roundish or irregular, small, reddish and later dead brown spots appear in great numbers. The shriveling tissue pulls away from the sound part of the leaf and finally drops out leaving a "shot hole." Sometimes the spots coalesce along the margin giving the leaf a burned or blighted appearance and if they break away, a ragged appearance. Black spot of plum, black spot of peach, bacterial shot hole, bacterial leaf spot, bacterial canker of stone fruits.

Hosts: *Amygdalus persica*, *Amygdalus persica nectarina*, *Prunus americana*, *Prunus armeniaca*, *Prunus armeniaca* var. *anzu*, *Prunus avium*, *Prunus buergeriana*, *Prunus cerasus*, *Prunus crassipes*, *Prunus domestica*, *Prunus donarium* subsp. *elegans* var. *glabra*, *Prunus japonica*, *Prunus mume*, *Prunus mume* var. *bungo*, *Prunus mume* var. *microcarpa*, *Prunus salicina*, *Prunus virginiana*, *Sorbus japonica*.

Geographical distribution: This disease occurs in practically all of the central and eastern states, in Japan, and possibly on peaches in northern Italy and Holland.

Control: Spraying for control of this disease has not been satisfactory because of injury to the trees. Roberts and Pierce (1929) however found that a spray of zinc sulphate 4 lbs., hydrated lime 3 lbs., casein lime ½ lb., water 50 gallons, in six applications made at intervals of two weeks beginning at petalfall decreased appreciably the spotting of leaves and defoliation and the number and size of

fruit infections. Proper pruning, cultivation and fertilization appear to be the best means of control as trees in good growing condition are resistant. Trees with an adequate supply of nitrogen do not defoliate. Roberts and Pierce (1923) recommend 2–3 pounds of nitrate of soda per tree. Anderson (1925) recommends late applications of nitrate and applications of manure in the fall or winter. Higgins (1926) recommends in addition spraying with 5–5–50 Bordeaux mixture plus two per cent oil followed by lime sulphur in late April and early May. Valleau (1929) says "A constant adequate supply of nitrogen can best be supplied to peach trees by growing legumes in the orchard each year and disking the refuse into the ground or allowing it to lie on the surface." No varieties of peach are known to be immune. When planting a new orchard only trees from nurseries free from the disease should be used.

Literature:

1902. Bos, J. Ritzema. "Schrotschusskrankheiten" (Hagelschotziekten) [of peach leaves]. Meded. Phytopathologisch Laboratorium, Willie Commelin Scholten. Verslagover onderzoekingen, gedaan inen over inlichtingen gegeven van wege bovengenoemd laboratorium, Amsterdam in het jaar 1901: 76–77, 1902. Possibly this reference belongs here. No fungi were found in these spots but very many bacteria. From the title it would seem that the author ascribed the spots to hail. He did not connect the bacteria with the disease by any experiments, nor did he describe the bacteria.

1903. Smith, E. F. Observations on a hitherto unreported bacterial disease, the cause of which enters the plant through ordinary stomata. Science (n.s.) **17**: 456–457, 1903. (Abstr. of Address Soc. Plant Morphology and Physiology, Dec. 1902.) This is the first description of the disease, from plum.

1904. Clinton, G. P. Peach, *Prunus persica*. Bacterial spot. Rept. of Connecticut Agr. Exp. Sta. for 1903: 337, 1904. No cultures were made.

1905. Smith, E. F. Bacteria in relation to plant diseases **1**: 171, 1905.

1905. Smith, E. F. Bacterial infection by way of the stomata in black spot of the plum. Abstr. in Science **21**: 502, 1905.

1906. Clinton, G. P. Plum, *Prunus* sp., bacterial black spot, *Pseudomonas pruni* Sm. Ann. Rept. Connecticut Agr. Exp. Sta. for 1905: 273–274, 1906.

1906. Heald, F. D. Report on the plant diseases prevalent in Nebraska during the season of 1905. Nebraska Agr. Exp. Sta. Ann. Rpt. 19: 32–33, 1906.

1907. Jackson, H. S. Bacteriosis of plums. 16th, 17th and 18th Ann. Repts. Delaware College Agr. Exp. Sta. for 1904, 1905, 1906: 75–76, 1907. This is the "first report of cankers in the plum associated with bacteria and he obtained a few successful inoculations on plum twigs but did not identify his organism."

1907. Scott, W. M. A promising treatment for brown rot and other peach diseases. Proc. Amer. Pomological Society, **30**: 39–48, 1907.

1908. Clinton, G. P. Peach, *Prunus persica*, bacterial spot, *Pseudomonas pruni* Sm. Connecticut Agr. Exp. Sta. Rept. for 1907–1908. Report of the station botanist for 1908: 856, 1908.

1909. Heald, F. D. Symptoms of disease in plants. Univ. of Texas Bul. 135, Sci. Series **14**: 48–49, 1909.

1909. Rorer, J. B. A bacterial disease of peach. Mycologia **1**: 23–27, 1909. "He first saw the disease on peach fruits and was perhaps the first (1907 or earlier) to produce the disease on peach leaves. He also crossed the disease from plum to peach. He likewise observed canker on twigs of the peach closely associated with leaf spot, and plated out of such cankers a yellow organism which agreed culturally with the one obtained from the leaf spots. Finally, he could find no difference culturally between the organism obtained from the plum and that obtained from the peach."

1909. Smith, E. F. The occurrence of *Bacterium pruni* in peach foliage. Science **30**: 223–224, 1909. (Abstract.)

1911. Güssow, H. T. A new disease of peaches. Canada Exp. Farms Rept. for year ending March 31, 1911: 251, 1911. Report of Botanist.

1911. Smith, E. F. Bacteria in relation to plant diseases **2**: Figs. 12 and 13, Pls. 3 and 4, 1911.

1912. Heald, F. D., and F. A. Wolf. A plant disease survey in the vicinity of San Antonio, Texas. U. S. Dept. Agr., B. P. I. Bul. 226: 31–32, 1912.

1912. Lewis, I. M. A bacterial canker of plum twigs. Trans. Amer. Micros. Soc. **31**: 145–149, 1912.

1913. Mumford, F. B. Fertilizing peach trees. Missouri Agr. Exp. Sta. Bul. 111: 247–248, 1913. The author first noticed that plots of peach trees fertilized with nitrogen were free from this disease while adjacent plots not so treated were badly injured by it.

1914. Ideta, A. Hand-book of the plant diseases of Japan, p. 472, 1914. (In Japanese.)

1914. Ishiyama, S. On black spot disease of Japanese plum fruit caused by *Pseudomonas pruni* Sm. The Journal of Plant Protection (Tokyo) **1**: 48–51, 166–171, 1914.

1915. Rolfs, F. M. A bacterial disease of stone fruits. Cornell Univ. Agr. Exp. Sta. Memoir No. 8: 381–436, 1915. "The most complete single paper is that by Rolfs (1915) wherein we have the first careful survey of varietal resistance and susceptibility." "Rolfs established the bacterial origin of canker of peach, plum, apricot, and nectarine by obtaining cankers on twigs with pure cultures obtained from leaf spots on peach, plum, nectarine and apricot (1909). He also showed the canker and the leaf spot organism to be identical with the fruit spot organism by successful inoculations made on stems and leaves with pure cultures obtained from the fruits of the four hosts (1910). He also produced the spot disease on leaves of the four hosts with pure cultures obtained from twig cankers of each of these hosts (1911 and 1912). All first published in 1915." E. F. Smith, notes.

1916. Higgins, B. B. Plum wilt: Its nature and cause. Georgia Agr. Exp. Sta. Bul. 118: 1–19, 1916 (see p. 16). Author says Stuckey

and Temple attributed this plum disease to bacteria, and that he finds that the fungus which causes it can enter the plum through cankers produced by *Bact. pruni*.

1917. Anderson, H. W. The bacterial shot-hole of peach. Trans. Illinois Hort. Soc. (n.s.) **51**: 121–128, 1917.

1917. Oskamp, J. A new peach disease in Indiana. Rpt. Proc. Indiana Hort. Soc. 1916: 430–431, 1917.

1917. Roberts, J. W. Control of peach bacterial spot in southern orchards. U. S. Dept. Agr. B. P. I. Bul. 543: 7 pp., 1917. He states that the causal organism overwinters on twig lesions. The writer confirmed and extended Mumford's (1913) observations.

1918. Elliott, J. A. Arkansas peach diseases. Arkansas Agr. Exp. Sta. Bul. 149: 3–9, 1918.

1920. Anderson, H. W. Diseases of Illinois Fruits. Univ. of Illinois Agr. Exp. Sta. Cir. 241: 90–93, 105, 1920.

1921. Anderson, H. W. A survey report of the bacterial shot-hole of peach. Trans. Illinois State Hort. Soc. **55**: 137–144, 1921.

1921. Kuwatsuka, Kikuji. Some studies on the *Pseudomonas pruni* E. F. Smith. Ann. Phytopath. Soc. Japan **1**: 12–19, 1921. Japanese summary: p. 18–19.

1921. Wiltshire, S. P. A bacterial infection of plum trees. Journ. Bath & West & So. Co. Soc. **15**: 125–128, 1921.

1923. Bergey's Manual of Determinative Bacteriology, p. 179, 1923.

1923. Roberts, J. W., and Leslie Pierce. The bacterial spot of peach. Trans. Illinois State Hort. Soc. **56** (1922): 78–87, 1923.

1925. Adams, J. F. The defoliation of peach trees in relation to spray materials and bacterial shot-hole. Trans. Penisular Hort. Soc. **14**: 17–21, 1925.

1925. Adams, J. F. Department of Plant Pathology. Ann. Rpt. Delaware Agr. Exp. Sta. for year ending June 30, 1925, Bul. 141: 27, 1925.

1925. Anderson, H. W. Some observations on bacterial shot hole of peach. Trans. Illinois State Hort. Soc. (1924) **58**: 488–497, 1925.

1925. Brookes, R. St. John, K. Nain, and M. Rhodes. The investigation of phytopathogenic bacteria by serological and biochemical methods. Journ. Path. and Bakt. **28**: 203–209, 1925. See *Bacillus carotovorus*.

1925. Gregory, C. T. Disease-resistant fruits and vegetables. Hoosier Horticulture **7**: 35–39, 1925. No varieties of peach are known to be resistant to *Bacterium pruni*.

1925. Roberts, J. W. Unusual defoliation of peach trees due to active chlorine. U. S. Dept. Agric., Official Record 4 (No. 33): 5, 1925.

1926. Adams, J. F. Experiments with bacterial leaf spot. Ann. Rept. Delaware Agr. Exp. Sta. for year ending June 30, 1926 (Bull. 147): 30–33, 1926. *Bacterium pruni* overwinters in the twig cankers which act as a source of leaf infection in the spring.

1926. Anderson, H. W. Overwintering of *Bacterium pruni*. Phytopath. **16**: 55–57, 1926. The results of his experiments indicate that

initial infections in some cases at least come from bacteria which overwinter in dead leaves and that initial infection from bacteria overwintering in cankers is not the common source as stated by earlier writers.

1926. Anderson, H. W. Control of bacterial spot of peach with sodium silicofluoride. Phytopath. **16**: 79–80, 1926. (Abstract.)

1926. Higgins, B. B. Bacterial spot of peach. Georgia Agric. Exper. Sta. Circ. 79: 1–4, 1926.

1927. Anderson, H. W. A theory to account for the bactericidal action of sodium silicofluoride and lack of injury to host tissues. Phytopath. **17**: 50, 1927. (Abstract.)

1927. Anderson, H. W. The effect of sodium silicofluoride sprays on the peach and on the control of bacterial spot. Science **65**: 16–18, 1927.

1927. Forty-fifth report of the Ohio Agricultural Experiment Station for 1925–26, Bul. 402: 37, 1927.

1928. Anderson, H. W. Bacteriophage of *Bacterium pruni*. Phytopath. **18**: 144, 1928. (Abstract.)

1928. Link, Geo. K. K., and A. DeS. Link. Further agglutination tests with bacterial plant pathogens. I. *Bacterium campestre-Bact. phaseoli* group; *Bact. medicaginis* var. *phaseolicola; Bact. tumefaciens*. Bot. Gaz. **85**: 178–197, 1928.

1928. Valleau, W. D. *Bacterium pruni* problem in Kentucky. U. S. Dept. Agric., B. P. I. Plant Disease Reporter **12**: 100–102, 1928.

1928. A year's progress in solving farm problems of Illinois, 1927–1928. Forty-first Ann. Rept. Illinois Agric. Exp. Sta. for year ending June 30, 1928: 267–268, 1928. Bacterial spot of peach caused heavy losses in 1927.

1929. Adams, J. F. Report of the Plant Pathologist for 1928. Quart. Bull. State Board of Agric., Delaware, **19**: 18, 1929. Severe infection of peaches and plums by *Bacterium pruni* is reported.

1929. Haskell, R. J. Diseases of fruit and nut crops in the United States in 1928. U. S. Dept. Agric., B. P. I. Plant Disease Reporter Sup. 70: 215–217, 225, 228, 1929. "During recent years *Bacterium pruni* seems to be becoming increasingly troublesome. In 1928 it was probably the most serious it ever has been for the country as a whole. Of the peach diseases, it appeared to be second only to brown rot."

1929. Roberts, J. W., and Leslie Pierce. A promising spray for the control of peach bacterial spot. Phytopath. **19**: 106–107, 1929. (Abstract.)

Bacterium pseudozoogloea Honing, 1914

Motile by one to two polar flagella; 0.7–1.0 x 0.9–2.5μ; chains; no spores; Gram negative; facultative anaerobe; agar colonies round, flat, yellowish grey; gelatin liquefied; milk coagulated but not cleared; no gas; acid from dextrose, lactose, maltose, sucrose, mannit; hydrogen sulphide and ammonia produced; no indol; fluorescent in gelatin; nitrates not reduced; growth on potato yellow,

glistening, becoming yellowish brown; bouillon moderately clouded, with round or oval pseudozoogloea in the pellicle.

Synonymy: *Phytomonas pseudozoogloeae* (Honing) Bergey et al., 1930.

Symptoms: The first signs of the disease are round dark green leaf spots which soon turn brown-black with concentric markings and dark gray borders. The dark green color of young lesions remains green when the leaf is dried while the healthy parts turn brown. Black Rust.

Host: *Nicotiana tabacum.*

Geographical distribution.—Dutch East Indies, Sumatra, and Java.

Control: All infected leaves should be gathered and burned.

Literature:

1899. Van Breda de Haan J. Verslag omtrent den staat van's Lands Plantentuin te Buitenzorg over het jaar 1898: 60–61, 1899.

1901. Hunger, F. W. T. Overzicht der ziekten en beschadigingen van het blad bij Deli-tabak. Meded. uit's Lands Plantentuin. 47: 7, 1901.

1914. Honing, J. A. De "zwarte Roest" der Deli-Tabak. Meded. van het Deli Proefstat. te Medan. 8: 107–111, 1914.

1914. Honing, J. A. De zwarte roest der Deli-tabak. The black rust of Deli tobacco. (English Summary.) Bul. van Het Deli Proefstation Medan, 1: 1–16, 1914.

1921. Palm, B. T. Een gevaar voor de tabakscultuur in Deli. Bul. Deli Proefstat. te Medan-Sumatra, 14: 9 pp., 1921. (English Summary.) From Rev. Appl. Mycol. 1: 275, 1922. *Bact. pseudozoogloeae* occurs at Deli in Sumatra and Vorstenlauden in Java.

1926. Jochems, S. C. J. Handleiding voor de herkenning en bestrijding van de Ziekten van Deli-Tabak. Mededeel. van Het Deli Proefstation te Medan-Sumatra. Tweede Ser. No. 43: 10–11, 1926.

1930. Bergey's Manual of Determinative Bacteriology, p. 242, 1930. (3rd ed.)

Bacterium puerariae Hedges, 1927*

Motile by one polar flagellum; 0.3–0.48 x 0.86–1.67μ; chains; no spores; no capsules; Gram negative; not acid fast; aerobic; gelatin liquefied; beef-infusion agar colonies bluish white or opalescent, round becoming crenate or lobed, smooth, glistening; nitrates not reduced; ammonia produced; no hydrogen sulphide; no indol; blue green fluorescence in beef infusion bouillon, agar, gelatin, Uschinsky's and Fermi's solutions; slight diastatic action; acid from glucose, sucrose, galactose, levulose, glycerin; no gas; no acid and no coagulation in milk; milk slowly cleared; litmus in milk not reduced; potato cylinders grayed, growth cream colored; optimum temperature 22°C.; maximum above 33°C.; minimum below 2.5°C.; thermal death point above 55°C.

Synonymy:

Bacterium pueriae Hedges, 1927.

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* Miss Hedges has recently found that this organism is a synonym of *Bacterium medicaginis* var. *phaseolicola* (Burkholder) Link and Hall, and will publish a note to that effect in Phytopathology.

Phytomonas puerariae (Hedges) Bergey et al., 1930.

Symptoms: Young leaf lesions are angular and water-soaked. Later the center becomes brown and is surrounded by an irregular translucent area. Older spots have a wide yellow halo. Glistening brown streaks also occur on young runners. Infection takes place through the stomata.

Hosts: *Phaseolus lunatus macrocarpus, Pueraria thunbergiana.*

Geographical distribution: Georgia, Florida, Connecticut.

Control: It is thought that the disease may be spread by planting runners from infected fields and the writer therefore recommends the planting of only well established roots from which bits of dead leaves and runners have been removed. The roots should be selected from disease-free fields.

Literature:

1927. Hedges, F. Bacterial halo spot of kudzu. Phytopathology **17**: 48, 1927. (Abstract.)

1927. Hedges, F. Bacterial halo spot of kudzu (*Pueraria thunbergiana*) caused by *Bacterium puerariae* Hedges. Journ. Agr. Res. **36**: 419–428, 1928.

1930. Bergey's Manual of Determinative Bacteriology, p. 243, 1930. (3rd ed.)

Bacterium (?) pyri Brzezinski, 1903

2.0 x 0.6–0.7μ; chains; Gram negative; yellow; destroys starch; liquefies gelatin; aerobic. He did not pour plates to obtain pure cultures and the results of his inoculations are not convincing.

Symptoms: This organism is said to cause cankers or tumors on the branches, nodules on the roots and yellow to brown veins in the wood of pear trees.

Host: *Pyrus communis.*

Geographical distribution: Central Europe.

Literature:

1903 Brzezinski, M. J. Le chancre des arbres, ses causes et ses symptoms. Bul. Internat. de L'Acad. des Sci. de Crocovie, Classe des Sci. Math. e Nat. 130–139, Mars. 1903.

Bacterium ricinicola

Polar flagella; 0.4–0.9 x 1.3–2.6μ; no spores; short chains; capsules; Gram negative; not acid fast; aerobic; nutrient agar colonies lemon yellow gradually changing to brown; gelatin liquefied; casein peptonized without coagulation; litmus milk slightly acid, then reduced; acid but no gas from lactose; nitrates not reduced; strong diastatic action; feeble growth in Uschinsky's solution; no growth in Cohn's; optimum temperature 29°–30°C.; maximum 39°C.; minimum about 2.5°C.; thermal death point 50°–51°C.

Synonymy: *Bacterium ricini* Yoshi and Takimoto, 1928. (To avoid confusion with *Phytomonas ricini* (1927) this organism is renamed.)

Symptoms: Numerous, irregular, brown, water-soaked lesions 2–5 mm. in diameter occur on the leaves, followed by premature defoliation. Similar spots were produced on the stem by artificial inoculation. There is no wilting of affected plants.

Host: *Ricinus communis.*

Geographical distribution: Korea; Fukuoka, Japan.

Literature:

1928. Yoshi, H., and S. Takimoto. Bacterial leaf blight of castor bean. Journ. Plant Protection (Tokyo) **15**: 12–18, 1928.

Bacterium (?) rubefaciens Burr, 1928

Motile but flagella not demonstrated; 0.5 x 1.6μ; no spores; no chains; Gram negative; gelatin colonies small, round to irregular, primuline yellow; gelatin slowly liquefied; acid without gas from lactose, arabinose, galactose, saccharose; grows on media of pH 5.7–pH 7.7.

Synonymy: See *Pseudomonas solaniolens*.

Symptoms: Sprain or internal rust spot is characterized by "rusty brown lesions in the form of isolated spots, streaks or irregular blotches in which cavities are frequently present and which often coalesce to produce large areas of disease." Sprain attacks the parenchyma within and without the vascular ring sometimes crossing the latter. The spots are more or less completely surrounded with a zone of cork the inner layers of which are suberised. The disease develops rapidly in storage until finally the whole flesh of the tuber may be destroyed, the skin shrivels, and the whole potato becomes hard and corky in texture. Canker.

Host: *Solanum tuberosum.*

Geographical distribution: England, Scotland, Holland, Germany, Rhodesia.

Control: Infection of the crop arises mainly from contaminated soil. In a series of variety tests Golden Wonder, Bishop, and Field Marshal were very susceptible to the disease, King Edward and Great Scot were less susceptible and Resistant Snowdrop, Catriona, and Majestic were highly resistant. Ploughing in of a green manure before planting the potatoes proved highly successful in warding off the disease. Only clean seed should be used and crop rotation should be practiced.

Literature:

1897. Frank, A. B. Das Buntwerden oder die Eisenfleckigkeit der Kartoffeln. Kampfbuch gegen die Schädlinge unserer Feldfrüchte, pp. 211–212, 1897.

1898. Frank, A. B. Untersuchungen über die verschiedenen Erreger der Kartoffel fäule. Ber. Deut. Bot. Gesell. **16**: 286–287, 1898.

1908–10. Horne, A. S. The symptoms of internal disease and sprain (streak disease) in potato. Journ. Agric. Sci. **3**: 322–332, 1908–10.

1914. Horne, A. S. Potato diseases. Ann. Appl. Biol. **1**: 194–196, 1914.

1923. Paine, S. G. "Internal rust spot" disease of the potato tuber. (synonyms: sprain, net necrosis, eisenfleckigkeit, kringerigheid, buntwerden, und maladie des taches en couronne). Rept. Internat. Conf. Phytopath. and Econ. Ent. Holland, 1923: 74–78, 1923.

1926. Atanasoff, D. Sprain or internal brown spot of potatoes. Phytopath. **16**: 711–722, 1926.

1926. Millard, W. A. Internal rust spot of potatoes. Nature **118**: 804, 1926. He states that phloem bundles are not directly attacked although they may ultimately become involved. They may thus

be definitely dissociated from net necrosis which is primarily an infection of the phloem bundles.

1928. Burr, S. Sprain or internal rust spot of potato. Ann. Appl. Biol. 15: 563–585, 1928.

1929. Burr, S. Sprain or internal rust spot of potatoes. *Bacterium rubefaciens.* Univ. of Leeds and Yorkshire Council for Agric. Education Bul. 160: 1–24, 1929.

1929. Hopkins, J. C. F. Two common diseases of potato tubers in Rhodesia. Rhodesia Agric. Journ. 26: 257–259, 1929.

Bacterium rubrilineans (Lee, Purdy, Barnum, Martin) n. comb.

Motile by one to three polar flagella; 0.7 x 1.67μ; no capsules; no spores; Gram negative; facultative anaerobe; glucose agar colonies small, smooth, glistening, light buff and opalescent; growth on potato warm buff, tawny or russet; gelatin liquefied; slight diastatic action; no indol; no hydrogen sulphide; milk cleared without coagulation; nitrates reduced; ammonia produced; no gas; acid from glucose; alkaline reaction from sucrose, lactose, glycerin; thermal death point 51°–52°C.

Synonymy:

Phytomonas rubrilineans Lee, Purdy, Barnum, Martin, 1925.

Pseudomonas rubrilineans (Lee, Purdy, Barnum, Martin) Stapp, 1928.

Symptoms: Young canes 6 in. to 3 ft. high are conspicuously marked with long, narrow, dark red, longitudinal streaks on the leaves. The disease first appears as watery, dark green streaks, spreading up and down the leaf and gradually turning bright red. Streaks are ½ to 1 mm. wide or coalesce to form broad bands. Only in severe cases do the streaks run down onto the leaf sheaths. Middle-aged leaves are more often infected than old or young ones. Infection of young central shoots often results in top rot. The organism enters through the stomata of the leaves. This is primarily a disease of the parenchyma although the organism may ultimately be found in the xylem and phloem. The disease is apparently transmitted by cuttings.

Host: *Saccharum officinarum.*

Geographical distribution: Island of Hawaii; Louisiana, U. S. A.; probably in Australia and the Philippines; Java; Porto Rico.

Control: Disinfection of instruments used in infected areas and of clothes of workers is urged. No cuttings should be transferred from infected to healthy districts. Early planting and harvesting and timely applications of nitrogenous fertilizers is recommended. The use of resistant varieties will probably be the ultimate means of control. B. Kohala 107, 115, 117; Badila; Yellow Coledonia; D1135 are practically immune.

Literature:

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Bacterium (?) salicis Day, 1924

Believed to be motile but flagella were not stained; 0.3–0.4 x 0.8–1.0μ; no spores; capsules; Gram positive; not acid fast; aerobic and facultative anaerobic; beef-peptone-sucrose agar colonies slow growing, small, round, convex, smooth, glistening, white, transparent; gelatin not liquefied; milk not coagulated; no acid or gas in litmus milk; nitrates not reduced; acid from dextrose, sucrose, mannitol, salicin, maltose, glycerin; no gas or only very slight amount in fermentation tubes; no acid or gas with lactose; moderate clouding and no pellicle in beef-peptone-sucrose broth; no growth in Cohn's solution and little or no growth in Uschinsky's; no fluorescence on any media; a typical bright yellow streak develops around the base of potato cylinders.

Synonymy: (Tubeuf suggests this may be the same as the elm disease *Micrococcus ulmi*, but he made no cross inoculations.)

Symptoms: In early stages the symptoms are a general wilting, withering and browning of leaves and tips of new shoots on one or more branches. The brown leaves may remain on the tree for some time. A thin, sticky, colorless, transparent liquid exudes from insect wounds covering the surface of the branch with a shiny varnish-like layer. In later stages the bark of branches bearing withered leaves and twigs dies back gradually. The disease progresses each season until the tree dies. Blackening of the wood is limited chiefly to the last year's wood and may be traced from the dying branches into the main trunk. Vessels are plugged with masses of bacteria and starch disappears from infected wood and bark.

Hosts: *Salix alba, Salix alba caerulea.*

Geographical distribution: Essex and Herfordshire, England.

Control: Wet subsoil and close planting should be avoided. Diseased trees should be removed and destroyed as soon as observed. Only carefully selected, healthy, vigorous sets should be planted.

Literature:

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1925. Tubeuf, H. von. Gefassbewohnende Bakterien im Holz von Baumen als verursacher todlicher Krankheit. Forstwiss. Centralb. 47: 348–351, 1925.

Bacterium savastanoi E. F. Smith, 1908

Motile by one to four polar flagella; 0.4–0.8 x 1.2–3.0μ; no spores; chains; Gram negative; not acid fast; aerobic; nutrient agar colonies slow-growing, translucent to pure white, circular, flat, smooth, glistening, entire; gelatin colonies have undulate-erose, frilled, lobed or incised margins; on steamed potato there is often a soluble brownish stain; gelatin and blood serum not liquefied; no gas; nitrates not reduced; acid from dextrose, sucrose and galactose; milk cleared without coagulation; slight indol production; good growth in Cohn's solution without fluorescence; light clouding in Uschinsky's solution with thin white pellicle and no fluorescence; maximum temperature 35°C.; minimum 1°C.; thermal death point 43°–46°C.

Synonymy:

Bacillus oleae tuberculosis Savastano, 1889.
Pseudomonas savastanoi (E. F. Smith) Stevens, 1913.
Phytomonas savastanoi (E. F. Smith) Bergey et al., 1923.
Names of doubtful import to be rejected (E. F. Smith 1908):
Bacterium oleae Arcangeli, 1886.
Bacillus Prillieuxianus Trevisan, 1889.
Bacillus oleae (Arcangeli) Trevisan, 1889.
Bacterium oleae Trevisan, 1889.
See *Bacterium tonnellianum* Ferraris, 1926.
Comes (1891) and Migula (1900) accept *Bacillus oleae* (Arcangeli).

Symptoms: This organism causes irregular spongy, more or less hard, knotty growths on roots, trunk, branches or leaves. These begin as tiny swellings which in a few months develop to knots of considerable size, more or less round and irregularly fissured. Terminal shoots when attacked cease to grow, are dwarfed or killed and sometimes whole trees are killed. Secondary growths often developed around dead tubercles. The disease usually persists from year to year attacking new shoots or lower parts of old branches. Knots may form at a distance from the original growth due to migration of bacteria through the spiral vessels of the wood which are browned and more or less disorganized. The bacteria are intercellular finally forming irregular branched cavities lined with water-soaked brown cells. Bacteria are abundant in the knots and during rainy weather ooze to the surface in large numbers and enter by wounds to form other tumors. The knots may be made up of wood, bark and vessels but are largely parenchyma tissue.

Hosts: *Chionanthus virginica*, *Forestiera acuminata* (*Adelia acuminata*), *Fraxinus floribunda*, *Fraxinus velutina*, *Jasminum primulinum*, *Olea* sp., *Osmanthus aquifolium*.

Geographical distribution: All around the Mediterranean; California; Argentine; Mexico.

Control: Foex (1924) says "Propagation by cuttings is to be avoided and seed used in preference." Pagliano (1924) suggests the possibility of selecting resistant varieties. Del Canizo recommends careful pruning and selection of grafts from healthy trees, burning of diseased branches, applications of manure to make the soil more acid, cutting out of large tumors and disinfection of wounds with ferrous sulphate or phenol and a subsequent coating of tar or paste. The following made good wound dressings: wax; vaseline; and fat 500–500–50, at 50–60°C.; or yellow wax; turpentine; pitch and fat 500–500–250–100 at ordinary temperatures. Pruning instruments should be sterilized each time they are used. Bellini recommends spraying with Bordeaux mixture after hail storms. For control of stem end and center rot of tomato see *Bact. malvacearum.*

Literature:

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Bacterium seminum (Cayley) Stevenson, 1926

Motile by one polar flagellum; 1.0 x 4.0–10.0μ; chains; capsules; spores; Gram positive; not acid fast; colonies on artificial media vary considerably in size and general characteristics, being opaque white or whitey-buff and more or less circular, or less opaque, more or less widely radiating, and may almost cover the

whole surface of the petri dish; facultative anaerobe; a pellicle is formed in beef bouillon; growth on potato chunks creamy, contoured, occasionally with a pinkish tinge; gelatin rapidly liquefied; no gas; acid from dextrose, sucrose; milk is cleared without coagulation; litmus in milk is slowly reduced gradually passing from a grayish tinge to a clear apricot color and finally to a deep wine shade; nitrates reduced; no diastatic action.

Pieces of infected tissue were dropped into nutrient broth and held for at least 10 days before satisfactory platings could be made. Plants grown in sterile soil and inoculated showed no disease. This is the writer's own statement "Inoculation experiments were carried out in the open but little stress can be laid upon the results as the disease was so prevalent throughout the experimental plots."

Synonymy:

Pseudomonas seminum Cayley, 1917.

Phytomonas semina (Cayley) Bergey et al., 1930.

Symptoms: This is said to be a seed-borne disease. Brown discolored areas occur in the center of each cotyledon. These may be mere spots or involve nearly the whole cotyledon. The young embryo may be infected and in severe cases cavities form in the centers of the cotyledons. In bad cases there is little or no germination. The shoot may develop normally or may be abortive, brown and dead at the tip with lateral shoots growing out prematurely. Early in the development of the plant light brown longitudinal streaks may be seen on the stem and root. No further signs are noticeable until the flowering period. The plants may then develop an unhealthy color, the stems turn brown and water-soaked and brown longitudinal streaks may appear at the base of the petiole. These streaks may split open and dry out. The leaves become spotted and yellowish with darkened veins. The surfaces of the pod become roughened. Healthy and diseased seeds have never been found in the same pod.

Host: *Pisum sativum.*

Geographical distribution: Southern England.

Control: Rotation of crops, early sowing, good drainage, sufficient lime in the soil, use of seed from healthy plants and the burning of refuse from infected crops, are recommended.

Literature:

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Bacterium sesamicola Takimoto, 1927

Motile by two to five polar flagella; 0.6–0.8 x 1.2–3.8μ; no spores; chains; Gram negative; aerobic; nutrient agar colonies white, circular, thin, and slightly raised, smooth, glistening; slight clouding in bouillon with pellicle, the medium

clearing again after a month; gelatin slowly liquefied; growth on potato flat, dirty white, medium greyed; no diastatic action; milk cleared without coagulation; slight growth in Cohn's and Uschinsky's solutions, medium green in latter; acid from dextrose; no acid from sucrose, lactose, mannit and glycerin; nitrates not reduced; no indol; no ammonia; no gas; optimum temperature 30°C.; maximum 35°C.; minimum 0°C.; thermal death point 49°C.

Symptoms: The disease first appears when the plants are 1.0–1.5 cm. high. Lesions appear mostly at the bases of the petioles and spread to the leafblades forming angular dark brown spots bounded by the veins and covered with exudate on the lower surface. The center of the spot becomes coal black with a light brown margin. Spots dry and break away leaving holes in the leaves. Seriously infected leaves gradually fall.

Host: *Sesamum orientale* (*indicum*).

Geographical Distribution: Chosen and Kyushiu, Japan.

Literature:

Takimoto, K. (Sesame bacterial spot disease.) Journ. Plant Protection (Tokyo) 8: 433–439, 1927.

Bacterium solanacearum (E. F. Smith) E. F. Smith, 1914

Motile by means of one polar flagellum; 0.5 x 1.5μ; no spores; no capsules; Gram negative; aerobic; agar colonies small, irregularly roundish, smooth, wet shining, opalescent (white by reflected light, pale brownish by transmitted light) becoming brown through the formation of a dark colored, water soluble pigment; grown on steamed potato cylinders the bacterial slime is white at first becoming gradually dark brown or black; milk cleared without precipitation of the casein; gelatin not liquefied (at least during first few weeks); nitrates reduced; no gas; no acid from dextrose, sucrose, lactose, maltose; no indol; good growth in beef bouillon with browning of medium and slight pellicle; slight diastatic action; no growth in Cohn's solution; ammonia produced; optimum temperature 35°–37°C.; maximum about 41°C.; minimum about 10°C.; thermal death point about 52°C.

Synonymy:

Bacillus solanacearum E. F. Smith, 1896.
Bacillus nicotianae Uyeda, 1904. (See Honing, 1912, 1913 and Nakata, 1927.)
Bacillus sesami Malkoff, 1906.
Pseudomonas sesami Malkoff, 1906.
Bacillus musae Rorer, 1911. (See Smith, 1914, and Ashby, 1926, 1928.)
Pseudomonas solanacearum E. F. Smith, 1914.
Bacillus musarum Zeman, 1921.
Erwinia nicotianae (Uyeda) Bergey et al., 1923.
Phytomonas solanaceara (E. F. Smith) Bergey et al., 1923.
See *Phytomonas ricini*.

Symptoms: This is a vascular disease causing dwarfing, sudden wilting and shriveling of foliage and a brown stain of the vascular bundles. This brown stain is often visible from the surface of infected stems as dark patches or streaks. Tobacco and potato leaves sometimes show brown veins. There is often an extensive destruction of pith leaving bacterial cavities in the stems of tomato and tobacco. Infection of potato tubers enters through the stolons, browning the vascular ring and later forming cavities which may extend to the surface.

Granville wilt, wilt disease, slime disease, bacterial ring disease, brown rot of Solanaceae, lier, lengkèr, schleimkrankheit, chancre bactérien, slucak, tachigare-byo, kuromushi, ichobyo, "vrot pootje," ring disease of bangdi, bangle blight.

Hosts: *Commelinaceae—Commelina nudiflora; Musaceae—Musa cavendishi, Musa paradisiaca, Musa sapientum; Cannaceae—Canna glauca, Canna indica; Orchidaceae—Vanilla planifolia; Urticaceae—Fleurya interrupta; Polygonaceae—Polygonum tinctorum, Rheum rhaponticum, Rumex sagittatus; Amaranthaceae—Amaranthus gangeticus; Phytolaccaceae—Phytolacca octandra; Capparidaceae—Polanisia viscosa; Leguminosae—Arachis hypogaea, Cassia lechenaultiana, Indigofera arrecta, Macuna* sp., *Phaseolus calcaratus, Phaseolus lunatus, Phaseolus radiatus, Phaseolus vulgaris* var. *nanus, Pisum sativum, Sesbania grandiflora, Soja max, Stizolobium niveum, Tephrosia vogelii, Vigna catjang, Vigna sinensis; Tropaeolaceae—Tropaeolum lobbianum, Tropaeolum majus, Tropaeolum peregrinum; Euphorbiaceae—Acalypha boehmerioides, Croton glandulosus* var. *septentrionalis, Euphorbia hirta, Euphorbia nutans, Manihot glaziovi, Manihot ultissima, Phyllanthus niruri, Ricinus communis; Balsaminaceae—Impatiens balsamina, Impatiens sultani; Tiliaceae—Corchorus acutangulus; Malvaceae—Gossypium* sp., *Hibiscus cannabinus; Sterculeaceae—Melochia corchorifolia; Oenotheraceae—Fuchsia speciosa; Convolvulaceae—Ipomoea triloba; Boraginaceae—Heliotropium indicum, Heliotropium cannibinus; Verbenaceae—Lantana camara, Lantana aculeata, Verbena erinoides, Stachytarpheta indica, Tectona grandis; Labiatae—Hyptis brevipes, Leucas linifolia; Solanaceae—Browallia demissa, Capsicum annuum, Capsicum longum, Datura fastuosa (cornucopiae), Datura meteloides, Datura stramonium, Lycopersicum cerasiforme, Lycopersicum esculentum, Lycopersicum pyriforme, Nicotiana alata affinis, Nicotiana atropurpurea grandiflora, Nicotiana tomentosa (colossea), Nicotiana glauca, Nicotiana macrophylla, Nicotiana quadrivalvis, Nicotiana rustica, Nicotiana sanderae, Nicotiana silvestris, Nicotiana suaveolens, Nicotiana tabacum; Petunia* sp., *Physalis alkekengi, Physalis angulata, Physalis crassifolia, Physalis minimum, Physalis philadelphica, Salpiglossis sinuata, Schizanthus pinnatus, Solanum carolinense, Solanum melongena, Solanum nigrum, Solanum tuberosum; Scrophulariaceae—Scoparia dulcis; Pedaliaceae—Sesamum orientale; Martyniaceae—Martynia louisiana (proboscidia); Acanthaceae—Barleria lupulina, Ruellia tuberosa; Compositae—Ageratum conyzoides, Ambrosia artemisiifolia, Bidens bipinnata, Blumea balsamifera, Chrysanthemum coronarium, Cosmos bipinnatus, Dahlia rosea, Eclipta alba, Eleutheranthera ruderalis, Erechtites hieracifolia, Erigeron canadensis, Helianthus annuus, Senecio sonchifolius, Synedrella nodiflora, Tagetes erecta.*

Geographical distribution: Southern, central and eastern United States, Mexico, Trinidad, British Guiana, St. Vincent, St. Lucia, Porto Rico, Argentine, Paraguay, Norway, Switzerland, Austria, Italy, Russia, England, France, South Africa, Mauritius, India, Malay, Java, Sumatra, New Zealand, Australia, Philippines, Japan, China.

Control: The disease may be controlled by elimination from the seed bed through steam sterilization of the soil at 80°–100°C. for 45 minutes to one hour, disinfecting seed with corrosive sublimate, and spraying young plants with Bordeaux mixture. In the field infected leaves should be removed and destroyed and a rotation of crops practiced from which hosts of *Bacterium solanacearum*

are excluded. Kuijper (1929) found *Nicotiana sanderae, N. silvestris,* and *N. affinis* very susceptible.

Literature:

1890. Burrill, T. J. Preliminary notes upon the rotting of potatoes. Proc. 11th Ann. Meeting Soc. Prom. Agr. Sci., 21–22, 1890. This is the first note on this disease.

1894. Tryon, H. New potato disease. Ann. Rept. Dept. Agric. Queensland 1893–94: 2–4, 1894. He found a bacillus in the vessels of roots, tubers, stems.

1896. Smith, E. F. A bacterial disease of the tomato, eggplant and Irish potato. (*Bacillus solanacearum* n. sp.) U. S. Dept. Agric., Div. Veg. Phys. and Path. Bul. 12: 1–28, 1896.

1897. Van Breda de Haan, J. De Slijmziekte bij de Tabak in Deli. Teysmannia (Batavia, Java) **8**: 528–549, 1897. Disease produced by inoculations with pure cultures. (Smith 270, 1914.)

1898. Smith, E. F. Some bacterial diseases of truck crops. Trans. Peninsula Hort. Soc. (Del.) **11**: 142–147, 1898.

1898. Smith, E. F. On the nature of certain pigments produced by fungi and bacteria with special reference to that produced by *Bacillus solanacearum*. Proc. Amer. Assoc. Adv. Sci. **46**: 288, 1898.

1899. Iwanoff, K. S. Ueber die Kartoffelbakteriosis in der Umgegend St. Petersburg im Jahre 1898. Zeitschr. f. Pflanzenkr. **9**: 129–131, 1899. The author considers the disease he describes as similar to Smith's disease due to *B. solanacearum* but Jennison (1923) thinks it is probably the blackleg disease.

1899. Tryon, H. Potato disease. Queensland Agr. Jour. **5**: 57–63, 1899. Speaking of his name, *Bacillus vascularum solani*, he says: "The conclusion—previously suggested by Professor Galloway,—that the American and Australian diseases are identical is fully borne out, a verdict that any investigator, endowed with but little less of the spirit of scientific caution exercised by E. F. Smith, might have pronounced even in the meagre light of the information, derived from this Queensland source, that partially illuminated the question."

1901. Hunger, F. W. T. Een Bacterie-Ziekte der Tomaat. Meded. uit 's Lands Plantentium Batavia **48**: 4–57, 1901.

1901. Smith, E. F. Entgegnung auf Alfred Fischer's "Antwort" in betreff der Existenz von durch Bakterien verursachten Pflanzenkrankheiten. Centralbl. f. Bakt. **7**: 196–197, 1901.

1902. Johnson, T. Diseases of the potato and other plants in Ireland. Journ. Dept. Agric. Ireland **3**: 10–12, 1902. Reports the occurrence in Ireland of a bacterial disease with symptoms similar to those produced by *Bacillus solanacearum*.

1903. Butler, E. J. Potato diseases of India. Agr. Ledger **4**: 112–119, 1903. He discusses "bangle" blight, a disease he thinks may be the same as Smith's brown rot.

1903. Malkoff, K. Eine Bakterienkrankheit auf *Sesamum orientale* in Bulgarien. Centralblat. für Bakter. **11**: 333–336, 1903. He

describes the disease and results of inoculations but does not name the organism. He says further study of bacteria is in progress.

1904. Stevens, F. L. The history of the tobacco wilt in Granville County, North Carolina. U. S. Dept. Agric., Office Exper. Stations Bul. 142: 166–168, 1904.

1904. Uyeda, Y. On the tobacco wilt disease caused by a bacteria. Centralblatt für Bakter. **13**: 327–329, 1904.

1905. McKenney, R. E. B. The wilt disease of tobacco and its control. U. S. Dept. Agr., B. P. I. Bul. **51**: 5–8, 1905.

1905. Smith, E. F. Bacteria in relation to plant diseases **1**: plate 27, 1905. The plate shows wilted tobacco plants and the legend below states that he isolated an organism from the wilted plant with which he reproduced the disease. "The organism causing this disease is closely related to *Bacterium solanacearum*."

1905. Uyeda, Y. *Bacillus nicotianae* sp. nov. die Ursache der Tabakwelkkrankheit oder Schwarzbeinigkeit in Japan. Bul. Imper. Centr. Agr. Exp. Sta. Japan **1**: 39–57, 1905.

1906. Kirk, T. W. Bacteriosis (*Bacillus solanacearum*). Rept. Dept. Agric. New Zealand **14**: 352, 1906.

1906. Malkoff, K. Weitere Untersuchungen über die Bakterienkrankheit und *Sesamum orientale*. Centralblatt für Bakter. Paras. und Infek. **16**: 664–666, 1906.

1906. Van Breda de Haan, J. Rapport over Ziekte in den Aanplant van *Arachis hypogaea* (Katjangholle) in de Afdeelingen Koeningan en Cheribon der Residentie Cheribon. Oct., 1905. Teysmannia, Batavia, **17**: 52–63, 1906.

1907. Kirk, T. W. Brown rot of potatoes (*Bacillus solanacearum*). Rept. of Dept. Agric. New Zealand **15**: 168, 1907.

1909. Smith, E. F. The Granville tobacco wilt. U. S. Dept. Agric., B. P. I. Bul. 141: 17–24, 1909. This is the first paper proving the disease to occur in tobacco.

1910. Honing, J. A. De oorzaak der slijmzieke an proeven ter bestrijding. Mededeel. van Het Deli Proefstation te Medan (Sumatra) **5**: 1–19, 1910. He found the wilt disease of tobacco (*Bact. solanacearum*) on *Pouzolzia* (nettle), *Ageratum conyzoides*, *Physalis angulata*, *Spilanthes acmella*, *Pluchea indica*.

1910. Rorer, J. B. A bacterial disease of bananas and plantains. Proc. Agr. Soc. Trinidad and Tobago. **10**: 109–113, 1910.

1910. Rorer, J. B. Diseases of bananas. Bul. Dept. Agr. Trinidad, Port of Spain **9**: 157, 1910.

1911. Honing, J. A. De oorzaak der slijmziekte en proeven ter bestrijding II. Mededeel. van Het Deli Proefstation te Medan. **5**: 169–185, 1911.

1911. Rorer, J. B. A bacterial disease of bananas and plantains. Phytopathology **1**: 45–49, 1911.

1911. Rorer, J. B. West India Com. Circ. 26: 389–391, 1911.

1912. Honing, J. A. Beschrijving van de Deli-Stammen van *Bacillus solanacearum* Smith, de oorzaak der slijmziekte. Mededeel. van Het Deli Proefstation te Medan. 6 Jaargang 7 afl. 219–255, 1912. He compares the morphological, cultural and physiological characters of *Bacillus solanacearum* Smith and *Bacillus nicotianae* Uyeda and concludes that they are identical.

1912. Honing, J. A. Over de beweerde onvatbaarheid van *Nicotiana rustica* voor slijmziekte. Mededeel. van Het Deli Proefstation te Medan. Jaargang **7**: 95–98, 1912. *Nicotiana affinis*, *Nicotiana atropurpurea grandiflora*, *Nicotiana colossea*, *Nicotiana glauca*, *Nicotiana sanderae*, *Nicotiana silvestris*, recorded as hosts.

1912. Peters, L., and Schwarz, M. *Bacillus solanacearum* Smith (Schleimkrankheit) in "Krankheiten und Beschadigungen des Tabaks." Mitteilungen aus der Kaiserlichen Biologischen Anstalt für Land- und Forstwirtschaft. Heft. 13, 38–44. Berlin, 1912,

1913. Honing, J. A. Über die Identität des *Bacillus nicotianae* Uyeda mit dem *Bacillus solanacearum* Smith. Recueil des Frav. Bot. Neerl. **10**: 85–136, 1913.

1913. Honing, J. A. Über die variabilität des *Bacillus solanacearum* Smith. Centralb. f. Bakt. **36**: 491–499, 1913. Also in Mededeel van Het Deli Proefstation te Medan **7**: 196–228, 1912.

1913. Honing, J. A. Über Faulnisbakterien aus kranken Examplaren von einigen tropischen Metzpflanzen (Tobak, Sesam, Erdnuss, Djatti und *Polygala butyracea* Heckel). Centralb. f. Bakt. **37**: 364–384, 1913. He found *Sesamum* subject to *Bact. solanacearum.*

1913. Hutchinson, C. M. Rangpur tobacco wilt. Memoirs Dept. Agric. India. Bacter. Ser. **1**: 67–83, 1913.

1913. Jensen, H. Seijmziekte. Mededeel. van "Het Proefstation voor Vorstenlandsche Tabak." Batavia **5**: 48–60, 1913. "No infections with Uyeda's *B. nicotianae*—60 plants inoculated." (Smith 271, 1914.)

1914. Cook, M. T. The southern bacterial wilt in New Jersey. Phytopath. **4**: 277–278, 1914.

1914. Fulton, H. R., and J. R. Winston. A disease of peanut plants caused by *Bacterium solanacearum.* Phytopath. **3**: 72–73, 1913. (Abstract.) See also note by Dr. Smith. Smith, E. F. Bacteria in relation to plant diseases **3**: 271, 1914.

1914. Honing, J. A. Onderzoekingen over de virulentie van *Bacillus solanacearum* tegenover verschillende *Nicotiana*-soorten en-varieteiten. Bul. van Het Deli Proefstation Medan, **2**: 1–15, 1914. (English summary)—The following were infected with pure cultures of the same strain: *Nicotiana quadrivalvis* Pursh, *Nicotiana suaveolens* Lehm, *Nicotiana macrophylla* Lehm and many varieties.

1914. Smith, E. F. Bacteria in Relation to Plant Diseases. **3**: 218, 1914. In a sample of "bacteriosis of *sesamum*" from Vienna, Austria he found bacteria which in morphology and location in the tissues suggested *Bact. solanacearum.*

1914. Ideta, A. Hand-book of the plant diseases of Japan 480: 483–486, 1914. (In Japanese.)

1914. Smith, E. F. Brown rot of Solanaceae. Bacteria in relation to plant diseases. 3: 170–172, 174–271, 1914. Wilt disease of tobacco. 3: 231–233, 1914. For the history and early literature of this disease see pp. 203–219, 270–271.

1914. Van der Wolk, P. C. Onderzoekingen over de bacterieziekte speciaal met het oog op hore beinvloeding door onkruiden, met een aanhangsel over de serehziekte van het suikerriet. De Indische Mercuur 37: No. 28, 647–650, 1914. States his belief based on experiments that *Bacterium solanacearum* is also the cause of the sereh-disease of sugar cane prevalent in Java. Dr. Erwin Smith using virulent cultures of *Bacterium solanacearum* from tobacco and *Ricinus* made a number of inoculations in sugar cane (var. Lahainae) with negative results. He thinks perhaps the Sumatran form, *Bacterium solanacearum* var. *asiaticum*, if used for inoculation might have some effect but that the American form, *Bact. solanacearum* is harmless to sugar cane. He gives a list of plants attacked by *Bact. solanacearum.*

1915. Bryan, M. K. A nasturtium wilt caused by *Bacterium solanacearum.* Journ. Agr. Res. 4: 451–457, 1915.

1915. Fulton, H. R., and J. R. Winston. A disease of the peanut caused by *Bact. solanacearum.* N. Carolina Agr. Exp. Sta. Ann. Rept. (1913–1914) 36 and 37: 43–47, 1915.

1915. Groenewege, J. De gomziekte van het suikerriet veroorzaakt door *Bacterium vascularum* Cobb. Mededeel. van het Proefs. voor de Java-Suikerindustrie, Deel 5, no. 3, p. 72, 1915. Concerning the Asiatic form, Groenewege states that although he has made hundreds of isolations from all parts of Sereh-diseased cane in the last two years, he has never obtained *Bact. solanacearum.*

1916. Bancroft, C. K. Report on the working of the Botanic Gardens, Georgetown. Rept. Dept. Sci. and Agric. British Guiana, April–Dec. 1915: 10, 1916.

1916. Van der Wolk, P. C. Onderzoekingen over een onverwachte bacterieziekte in de Soja-plant, in aansluiting met een onderzoek naar het wezen der wortelknolletjes van *Glycine soja* en *Arachis hypogaea.* Cultura 28 No. 336, 268–285; 337, 300–319. (1916)

1917. Darnell-Smith, G. P. Report Dept. Agr. N. S. Wales for year ending June 30, 1916: 32, 1917.

1917. Garner, W. W., F. A. Wolf, and E. G. Moss. The control of tobacco wilt in the flue-cured district. U. S. Dept. Agric. B. P. I. Bul. 562, Sept. 15, 1917. They found no varieties resistant to the disease in Virginia and the Carolinas.

1917. Nowell, W. Bacterial diseases of tomatoes in St. Vincent. Agricultural News (Barbados) 116: 414–415, 1917. This is the first report of the wilt disease due to *Bacterium solanacearum* at Kingstown, St. Vincent. He also says it was reported in 1904 on tomatoes from Union, St. Lucia.

1917. Stanford, E. E. Studies on resistance of tomatoes to bacterial wilt. North Carolina Agr. Exp. Sta. 40th Ann. Rept., 92–93, 1916–1917. "It does not appear that resistance, in tomatoes, to bacterial wilt can be augmented by seed selection from plants which remain healthy to maturity."

1917. Stanford, E. E., and F. A. Wolf. Studies on *Bacterium solanacearum*. Phytopath. **7**: 155–165, 1917. They report several new host plants in North Carolina. "The economic bearing of these additional weed and cultivated host plants for *Bacterium solanacearum* upon the problem of wilt control is apparent" since some are widespread in cultivated fields and gardens and others are not uncommon weeds.

1917. Waters, R. Gravy eye, or mattery eye, in potatoes. Journ. Agr. (New Zealand) **14**: 357–362, 1917. This is a bacterial disease, the general characteristics of which agree with those of the American black rot of potatoes due to *Bact. solanacearum*.

1918. Darnell-Smith, G. P. Preliminary investigations on a bacterial disease of tobacco. Journ. and Proc. Roy. Soc. N. S. Wales **52**: 435–453, 1918.

1918. Darnell-Smith, G. P. Diseases of tobacco plants. Agr. Gaz. N. S. Wales **29**: 85–88, 1918.

1918. Orton, C. R., and W. H. McKinney. Notes on some tomato diseases. Ann. Rept. Pennsylvania Agr. Exp. Sta. 1915–16: 288–289, 1918.

1918. Smith, E. F., and G. H. Godfrey. Brown rot of Solanaceae on *Ricinus*. Science (n.s.) **48**: 42–43, 1918.

1919. Doidge, E. M. The rôle of bacteria in plant diseases. So. African Journ. Sci. **16**: 85, 1919.

1919. Reinking, O. A. Diseases of economic plants in southern China. The Philippine Agric. **8**: 119, 132, 1919.

1919. Sherbakoff, C. D. Solanaceous blight (brown-rot). Florida Agr. Exp. Sta. Ann. Rept. 1917–18: 71 R-74 R. 1919.

1919. Smith, E. F., and L. McCulloch, *Bacterium solanacearum* in beans. Science **50**: 238, 1919.

1920. Smith, E. F. The brown rot of solanaceae. Introduction to Bacterial diseases of Plants, pp. 177–201, 1920.

1921. Jochems, S. C. J. Twee nieuwe wilde waardplanten van *Bacillus solanacearum* E. Sm. Bull. Deli Proefst. Medan, Sumatra no. 13, 8 p., 1921. English summary (Two new hosts of *Bacillus solanacearum*): p. 8. *Canna glauca* Rose, *Canna indica* L., *Impatiens balsamia* L.

1921. Mann, H. H., S. D. Nagpurkar. The ring disease of potato. Dept. Agric. Bombay Bul. 102: 38–57, 1921.

1921. Palm, Bj. Slijmziekte in een rubberplant. Overgedrukt uit het Tijdschrift Teysmannia, Afl. 1: 31–33, 1921. *Manihot Glaziovii* infected in Java. The disease occurred naturally in a good many seedlings.

1921. Ramirez, R. Plagas de la Agricultura en el Distrito Federal. La Revista Agricola (Mexico) 5: 663, 1921.

1921. Smith, E. F., and G. H. Godfrey. Bacterial wilt of castor bean (*Ricinus communis* L.). Journ. Agr. Res. **21**: 255–261, 1921. *Bacterium solanacearum.*

1921. Zeman, V. Bacteriosis del bananero (una nueva enfermedad). Rev. Facul. Agr. Univ. La Plata **14**: 17–30, 1921.

1922. Jochems, S. C. J., and J. G. J. A. Maas. Slijmziekte in de *Hibiscus cannabinus* op Sumatra's Oostkust. Teysmannia **33**: 542–546, 1922. Petioles assume a horizontal position followed by drooping of the leaves usually all at the same time. The leaves curl up along the midrib and wither. *Bact. solanacearum* seriously destructive to new plantations of *Hibiscus cannabinus* on the east coast of Sumatra in 1922.

1922. Jørstad, I. Beretning om plantes-ykdommer i land-og havebruket 1920–21. I Landbruksvekster og grønnsaker, p. 71, 1922. *Bacillus solanacearum* is reported on tomato in Norway.

1922. Palm, B. T., and S. C. J. Jochems. Wilde planten en slijmziekte. Deli-Proefstat. te Medan (Sumatra) Vlugsch. **20**: 3 pp., 1922. They give a list of 34 wild plants in 19 families known to be susceptible to slime disease in Sumatra. These are many of them widely distributed. *Lantana aculeata* is most susceptible of all and should be replaced as a cover crop by *Mimosa invisa*, which is resistant.

1922. Palm, B. T. Aanteekeningen over slijmziekte in *Arachis hypogaea* (Katjangtanah). Meded. Inst. voor Plantenziekten **52**: 41 pp., 1922. (English summary.) He gives a list of new hosts in the Dutch East Indies.

1922. Vriend, J. Stachytarpheta vatbaar door slijmziekte. Vlugsch. Deli-Proefstat. te Medan (Sumatra) **16**: 4 pp., 1922. He reports the occurrence of slime disease in four localities in Sumatra on *Stachytarpheta indica.*

1922. Welles, C. G., and E. F. Roldan. Solanaceous wilt in the Philippine Islands. Philipp. Agric. **10**: 393–398, 1922.

1922. Wolf, F. A. Additional hosts for *Bacterium solanacearum.* Phytopath. **12**: 98–99, 1922.

1923. Bergey's Manual of Determinative Bacteriology, pp. 172–173, 186–187, 1923.

1923. Meier, F. C., and G. K. K. Link. Potato brown rot. U. S. Dept. Agric. B. P. I. Circ. 281: 1–6, 1923. During storage or transit tubers shoult be kept at or below 55°F. at which temperature growth of *B. solanacearum* is inhibited.

1923. Welles, C. G., and E. F. Roldan. Another economic host of *Bacterium solanacearum.* Phytopath. **13**: 488–491, 1923. They report a serious wilting of mature tango *Chrysanthemum coronarium* Linn. at Los Banos, Philippine Islands. Only very slight brownish pigment, whether originally isolated from tango or tomato, but if passed through tomato the pigment-producing power is regained. 0.66–1.77×0.22–0.55μ; ave. $1.22 \times 0.42\mu$.

1924. Krueger, A. P., and C. L. Alsberg. A metabolic study of *Bacterium solanacearum* EFS. Proc. Soc. Exp. Biol. and Med. 21: 534, 1924.

1924. Palm, B. T. Verslag van het Deli Proefstation over 1 Juli, 1923–31, December, 1924. Meded. Deli Proefstat. te Medan-Sumatra, Ser. 2, No. 40: 34 pp., 1925. "The protracted use of the resistant *Mimosa invisa* as a green manure has given very satisfactory results and promises to lead to the ultimate control of the disease in the field." R. A. M. 4: 638, 1925.

1924. Shepherd, E. F. Botanical Division. Ann. Rept. Dept. Agric. Mauritius for 1923: 10–11, 1924. Wilt of tobacco due to *Bacterium solanacearum* is reported. Imported on tobacco.

1924. Van der Goot, P. Overzicht der voornaamste Ziekten von het aardappelgewas op Java. Meded. Inst. voor Plantenziekten Bul. 18: 37–39, 1924.

1924. Van Hall, C. J. J. Ziekten en plagen der cultuurgewassen in Nederlandsch-Indië in 1923. Meded. Inst. voor Plantenziekten 64: 47 pp., 1924. They list varieties of *Arachis hypogaea* in Sumatra practically immune to *Bacterium solanacearum.*

1924. Vriend, J. Resistentie-selectie bij Deli-Tabak. Meded. Deli Proefstat. te Medan-Sumatra. Ser. 2, No. 33: 3–10, 1924. The results of breeding for resistance to slime disease were not very promising.

1925. Alston, R. A. Report of the assistant botanist and mycologist. Rept. Dept. Sci. and Agric. (British Guiana), for 1923: 39, 1925. Bacterial wilt of tomato (*Bacterium solanacearum*) is recorded from one locality.

1925. Hartley, C. Varietal tests of peanut (*Arachis hypogaea*) for wilt resistance. Phytopath. 15: 55, 1925. (Abstract.)

1925. Van Hall, C. J. J. Zeikten en plagen der cultuurgewassen in Nederlandsch-Indië in 1924. Meded. Inst. voor Plantenziekten 67: 53 pp., 1925. Rhubarb was infected with *Bact. solanacearum* in Preanger in Dutch East Indies.

1926. Ashby, S. F. A wilt disease of bananas. A bacterial wilt disease of bananas in Trinidad caused by *B. solanacearum.* E. F. Smith. Tropical Agriculture 3: 127–129, 1926. Pure culture inoculations on banana, tobacco and tomato gave typical symptoms of wilt. The symptoms agreed in every respect with those described by Rorer in 1910–1911 and the cultural characters of the organism agreed with those recorded for *Bacterium solanacearum* EFS.

1926. Mendiola, N. B., and G. O. Ocfemia. The work of breeding disease resistant crop plants at the College of Agriculture at Los Banos. Philipp. Agric. 15: 125–126, 1926. None of the six varieties of eggplant and tomato or of the twelve varieties of chilli pepper tested for resistance to bacterial wilt proved absolutely immune but Bolivian pepper was comparatively resistant.

1926. Palm, B. T. Verslag van het Deli Proefstation over 1 Januari 1925–35 December 1925. Meded. Deli Proefstat. Medan-Sumatra

no. 42: 35 pp., 1926. New hosts discovered during 1925, *Phytolacca octandra, Sesbania grandiflora, Ruellia tuberosa.*

1926. Roldan, E. F. Bacterial wilt of marigold or amarilla. Philipp. Agric. 15: 37–40, 1926. *Tagetes erecta* L.

1926. Schwarz, M. B. Slijmziekte in de Cassave. De Indische Culturen (Teysmannia 11: 498–499, 1926). He proved the disease on *Manihot ultissima* to be due to *Bact. solanacearum.*

1926. Schwarz, M. B. De invloed van de voorvrucht op het optreden van slijmziekte (*Bacterium solanacearum*) in *Arachis hypogaea* en eenige andere gewassen. Meded. Inst. Plantenziekten 71: 37 pp., 1926. (English summary by C. Hartley.) In Java *Arachis hypogaea* suffers badly from slime disease (*Bact. solanacearum*). A list of other hosts is given. While strain differences of *Bact. solanacearum* occur they should not be too confidently relied upon to protect differential hosts, since adaptation to comparatively uncongenial hosts may gradually be developed.

1927. Altson, R. A. Memorandum on Panama disease. Journ. Board Agric. British Guiana 20: 88–90, 1927. He believes the bacterial disease of plantains is identical with "moko disease" of Trinidad which has recently been shown to be due to *B. solanacearum.* The external and internal symptoms of plantain disease are similar to those of the Panama disease although the latter is due to *Fusarium cubense.*

1927. Ashby, S. F. Bacterial wilt disease of bananas. Kew Bul. Misc. Inform. 1927, 1: 14–18, 1927. He thinks this is the same disease described by Rorer, 1911. The cultural characters agree with those recorded for *Bact. solanacearum* EFS. and with pure cultures from wilted bananas he was able to reproduce the disease on tobacco and tomato.

1927. Corbett, G. Les maladies sur le tabac rencontrées a Maurice en 1926 avec des notes sur les Moyens de s'en preserver. Rev. Agric. de l'Isle Maurice 32: 65–68, 1927. Granville wilt may be controlled by crop rotation.

1927. Hartley, C. Notes on *Hibiscus* diseases in West Java. Phytopath. 17: 25, 1927.

1927. Kuijper, J. Het verband tusschen slijmziekte en voorafgaande begroeüng in de proef op Padang Boelan. Deli Proefstat. te Medan (Sumatra) Vlugschr. 41: 1–5, 1927. In all cases the disease was more severe on plots which had only lain fallow for 1½ to 3 years as compared with longer periods. He gives the results of tests of the effects of the preceding crop on the incidence of slime disease.

1927. Nakata, K. The tobacco wilt with special reference to the cause of the disease. Journ. Sci. Agric. Soc. (Tokyo) 294: 185–216, 1927. (Japanese with English summary.) Tobacco wilt is due to *Bact. solanacearum. Bact. nicotianae* Uyeda was not isolated even from the original locality. The characters of *Bact. sesami* are stated to agree with those of *Bact. solanacearum* which occurs naturally on *Sesamum indicum.*

1927. Nakata, K. Concerning the vitality and pathogenicity of *Bacterium solanacearum* Smith, a cause of tobacco wilt. Journ. Sci. Agric. Soc. (Tokyo) **296**: 283–304, 1927. (Japanese with English summary.)

1927. Nakata, K. Principles for controlling tobacco wilt. Journ. Sci. Agric. Soc. (Tokyo) **298**: 389–411, 1927. (Japanese with Eng. summary.)

1927. Schwarz, M. B. Voorloopige resultaten van een oriënteerende veeljarige vruchtwisselingsproef op sawahterrein in verband met slijmziekte (*Bacterium solanacearum*) in *Arachis hypogaea*. Korte Meded. Inst. voor Plantenziek. Buitenz. **3**: 1–11, 1927. English summary (Preliminary results of a crop rotation test in connection with slime disease (*Bacterium solanacearum*): continued cultivation of *Arachis* results in increased loss by slime disease but a one year rotation decreases the amount of disease in *Arachis* sufficiently. Results indicate bacterial strains of *Bact. solanacearum*. *Arachis hypogaea*, *Soja hispida*, *Vigna sinensis*, *Capsicum annuum*, *Solanum melongena* are susceptible to the disease.

1927. Schwartz, B., et C. Hartley. *Bacterium solanacearum* sur l'arachide et quelques autres plantes à Java. Rev. Bot. Appl. Agric. Colon. **7**: 355, 1927.

1927. Shepherd, E. F. S. Botanical Division, Ann. Rept. Mauritius Dept. Agric. for 1926: 15–18, 1927. Tobacco was attacked by Granville wilt (*Bacillus solanacearum*). He reports a wilting of bananas strongly suggestive of the Moko disease due to *Bacillus musae*.

1927. Tucker, C. M. Report of the Plant Pathologist. Rept. Porto Rico Agr. Exp. Sta. 1925: 34, 1927. Bacterial wilt is one of the most destructive diseases of tomatoes in Porto Rico. Immersion of roots in 0.25 per cent uspulun appears to be toxic to the bacteria without injuring the plants.

1928. Ashby, S. F. The bacterial wilt of bananas and plantains. Agric. Journ. British Guiana **1**: 217–220, 1928. The author is satisfied that the disease in British Guiana is the same as Rorer's Trinidad disease and due to *Bact. solanacearum*.

1928. Jochems, S. C. J. Vier nieuwe waardplanten van *Bacterium solanacearum* E. F. S. Bul. Deli Proefstat. te Medan-Sumatra, **27**: 29–32, 1928.

1928. Suryanarayana, Ayyar P. S. A method of selecting ring-disease free potato seeds for planting. Madras Agric. Dept. Year Book 1927: 37–42, 1928.

1928. Van der Goot, P. Ziekten en plagen der cultuurgewassen in Nederlandsch-Indie in 1927. Meded. Inst. voor Plantenziekten No. 74: 6, 7, 80, 1928. *Bacterium solanacearum* caused heavy losses of potatoes in Java and Sumatra.

1929. Kuijper, J. Verslag van het Deli Proefstation over het jaar 1928. Meded. Deli Proefstat. te Medan-Sumatra. **60**: 1–59, 1929.

Bacterium solanacearum var. asiaticum E. F. Smith, 1914

See *Bacterium solanacearum.* This is a strain of *Bacterium solanacearum* which reddens litmus milk and cream.

Host: See *Bact. solanacearum.*

Geographical distribution: See *Bact. solanacearum.*

Control: See *Bact. solanacearum.*

Literature:

1914. Smith, E. F. Bacteria in relation to plant diseases **3**: 282, 1914.

1920. Smith, E. F. An introduction to bacterial diseases of plants, p. 188, 1920.

Bacterium spongiosum (Aderhold und Ruhland) n. comb.

Motile by two to four polar flagella; 0.6–0.8 x 1.6–4.0μ; chains; no spores; 5 per cent cane sugar bouillon gelatin colonies thin, cream white, often transparent, and vacuolate when magnified sixty times; gelatin liquefied; 5 per cent cane sugar bouillon agar colonies raised, round, gray-white, slimy, sometimes transparent; slight growth in bouillon but good growth in sugar bouillon; little growth in Uschinsky's solution; milk cleared without coagulation; nitrates not reduced; ammonia produced; optimum temperature 20°–25°C.; maximum about 35°C.; minimum 1°–2°C.

Synonymy:

Bacillus spongiosus Aderhold und Ruhland, 1905. His illustrations show a polar flagellate organism and the tests (1906, 1907) state that they are polar.

Pseudomonas spongiosa (Aderhold und Ruhland) Braun, 1927.

See *Bacterium cerasi.*

Symptoms: The first signs of the disease are sunken spots in the bark with raised margins. These may crack open and gum may exude. Cross sections of these sunken spots show that the bark is browned and this discoloration may extend into the wood. These spots may increase in size until they girdle and kill the twigs and branches or the entire tree. Cavities form in the young bark due to destruction of phloem tissue. Young trees are usually killed. Older trees may not develop in the spring or may die at blooming time or the crown of a tree may suddenly wilt during June or July. Sometimes only a single healthy branch remains.

Host: *Prunus* sp.

Geographical distribution: Germany, Switzerland, Russia.

Control: All infected branches should be cut off and burned and bark lesions cut out and disinfected with coal-tar or pitch. The same control measures practiced with fire blight are recommended here.

Literature:

1905. Aderhold, R., und W. Ruhland. Ueber ein durch Bakterien hervorgerufenes Kirschensterben. (Vorlaufige mitteilung.) Centralb. f. Bakt. **15**: 376–377, 1905.

1906. Aderhold, R., und W. Ruhland. Über den Bakterienbrand der Kirschbaume. Kaiserliche Biolog. Anst. für Land und Forstw. Flügblatt No. 39: 1–4, 1906.

1907. Aderhold, R., and W. Ruhland. Der bakterienbrand der kirschbaume. Kaiserliche Biolog. Anst. für Land und Forstw. 5: 293-340, 1907.

1907. Aderhold, R., und W. Ruhland. Weitere Untersuchungen über den Bakterienbrand der Kirschbaume. (Siehe vorigen Jahresbericht S 18, nr. 13) Kaiser Biolog. Anstalt für Land und Forstw. 4: 25–26, 1907.

1908. Jachevsky, A. A. Annual Review of diseases and injuries of useful cultivated and wild plants. Dept. Agric. and Public Domain. St. Petersburg, (in Russian), 3 (1907): 92–98, 1908.

1924. Müller-Thurgau, H., and A. Osterwalder. Bericht der Schweizerischen versuchsanstalt für Obst., Wien- und Gartenbau in Wädenswil für die Jahre 1921–1923. III. 1. Pflanzenphysiologische und Pflanzenpathologische Abteilung. Landw. Jahrb. der Schweiz. 38: 573, 1924.

1926. Pape, H. Krankheiten und Beschädigungen der Kulturpflanzen im Jahre 1921. Mitt. Biol. Reichsanst. Land- und Forstw. 29: 191, 1926. Cherries suffered from blight. *Bacillus spongiosus*, in one locality in East Prussia.

1927. Braun, K. Bericht über das auftreten von Schädlingen und Krankheiten im Obstbau im Regierungsbezirk Stade während der Monate Juni, July und August, 1927. Die Landwirtschaft 41, 42, 2 pp., 1927 (from Rev. Appl. Mycol. 7: 177, 1928). *Pseudomonas spongiosa* repeatedly observed on plums and damsons.

Bacterium stizolobii (Wolf) McCulloch, 1928

Motile by one polar flagellum; 0.6–0.7 x 1.0–1.6μ; chains; no spores; capsules; aerobic; Gram negative; not acid fast; nutrient agar colonies glistening, smooth, white, raised, opaque, with entire or slightly undulate margins; gelatin not liquefied; growth on potato cylinders moderate, white, glistening, spreading or raised and lusterless on dry cylinders; no diastatic action; slight clouding in bouillon and no ring or pellicle; casein partially precipitated; no acid and no gas from glycerin, lactose, sucrose, dextrose; nitrates not reduced; no indol; optimum temperature 25°–28°C.; thermal death point near 50°C.

Synonymy:

Aplanobacter stizolobii Wolf, 1920.

Phytomonas stizolobii (Wolf) Bergey et al., 1930.

Symptoms: The signs of this disease are translucent, angular brown leaf spots. Lesions occur only on the foliage and appear first as small translucent dots which enlarge to 2–3 or even 8 mm. in diameter becoming dark brown and angular. The water-soaked border disappears in mature lesions. The centers are lighter colored than the margins and the surrounding tissues are chlorotic. There is no exudate. This is a disease of the parenchyma. The organism enters the stomata, occupying the intercellular spaces and finally disrupting the cell walls.

Host: *Stizolobium deeringianum.*

Geographical distribution: North Carolina.

Literature:

1920. Wolf, F. A. A bacterial leaf spot of velvet bean. Phytopathology 10: 73–80, 1920.

1928. McCulloch, L. *Bacterium stizolobii* (Wolf) comb. nov. (Syn. *Aplanobacter stizolobii*). Phytopath. 18: 460, 1928. A single polar flagellum was demonstrated.
1930. Bergey's Manual of Determinative Bacteriology, p. 244, 1930. (3rd ed.)

Bacterium striafaciens Elliott, 1927

Motile by one to several polar flagella; average measurements 0.66 x 1.76μ; capsules; chains; no spores; aerobic; Gram negative; not acid fast; beef agar colonies white, slightly raised, with entire to slightly undulate margins and internal fish-scale markings, agar slightly greened; beef bouillon shows clouding at top and bottom of tube with ring or thin pellicle; gelatin liquefied; no indol; hydrogen sulphid produced; soft curd in milk slowly peptonized; slight reduction of nitrates; diastatic action moderate; ammonia produced; acid from dextrose, sucrose, levulose; optimum temperature 22°C.; maximum 33–35°C.; minimum 1°C.; thermal death point about 48°C.

Synonymy: *Phytomonas striafaciens* (Elliott) Bergey et al., 1930.

Symptoms: Lesions first appear as sunken, water-soaked dots which when very numerous cause the collapse of the leaf tissue. These lesions grow into long water-soaked stripes or blotches which may show narrow yellowish margins. Under moist conditions exudate comes out in drops along the lesions and dries down to thin white scales. Older lesions turn a rusty translucent brown and may extend the length of the leaf blade. Lesions occur chiefly on the leaves but may appear on sheaths, culms, pedicels and glumes and sometimes kill the entire top of the plant.

Hosts: *Avena byzantina*, *Avena sativa*, *Avena sativa orientalis*, *Hordeum vulgare*.

Geographical distribution: Ohio, Indiana, Illinois, Wisconsin, Minnesota, South Dakota, North Dakota, California, Oregon, Washington.

Literature:

1918. Elliott, C. Bacterial oat blight. Phytopath. 8: 489–490, 1918.
1927. Elliott, C. Bacterial stripe blight of oats. Journ. Agr. Res. 35: 811–824, 1927.
1930. Bergey's Manual of Determinative Bacteriology, p. 243, 1930. (3rd. ed.)

Bacterium (?) suberfaciens Burr, 1928

Motile but flagella not demonstrated; 0.6 x 2.6μ; no spores; no chains; Gram negative; gelatin colonies not more than pin point in size after sixteen days, dew drop in appearance, margins entire to slightly undulate, cream buff in color; gelatin not liquefied; no acid or gas from carbohydrates; grows on media of pH 6.0 to pH 8.0.

Symptoms: "Corky bacteriosis" is essentially a disease of the xylem vessels characterized by rusty brown discoloration of the vascular ring which appears in isolated spots or streaks or which may form a complete ring. In the latter instance the disease bears a resemblance to ring bacteriosis (*Bacterium solanacearum*) from which it differs by the absence of any bacterial exudate, by the production of suberised cork tissue around the diseased elements, and by the

fact that it does not spread to the tissues on either side of the vascular ring. The disease is transmitted from mother tuber to its progeny by way of the stolons and is also contracted from infected soil through the stolon or stolon end of the tuber.

Host: *Solanum tuberosum.*

Geographical distribution: England, Rhodesia.

Control: Only clean seed should be used for planting and crop rotation should be practiced.

Literature:

1928. Burr, S. Sprain or internal rust spot of potato. Ann. Appl. Biol. **15**: 563–585, 1928.

1929. Hopkins, J. C. F. Two common diseases of potato tubers in Rhodesia. Rhodesia Agric. Journ. **26**: 257–259, 1929.

Bacterium syringae (van Hall) E. F. Smith, 1905

Motile by one to several polar flagella; 0.6 x 1.2–1.8μ; chains; no spores; capsules; Gram negative; agar colonies round or fimbriate, smooth or wrinkled, white; gelatin rapidly liquefied; green fluorescence in beef infusion media; litmus and methylene blue reduced; soft rennet curd formed in milk followed by peptonization; ammonia produced; no indol; no hydrogen sulphide; weak nitrate reduction; feeble diastatic action; good growth in Uschinsky's and Fermi's solutions; very feeble growth in Cohn's; acid from sucrose, dextrose, galactose, levulose, glycerin and mannit; no gas; optimum temperature 28°–30°C.; maximum 35°C.; minimum below 1°C.; thermal death point 51°C.

Synonymy:

Pseudomonas syringae van Hall, 1902.
Pseudomonas syringae Beyerinck, 1908.
Bacterium citriputeale C. O. Smith, 1913.
Bacterium citrarefaciens Lee, 1917.
Bacterium syringae (van Hall) Güssow, 1920.
Pseudomonas citrarefaciens (Lee) Stapp, 1928.
Pseudomonas citriputeale (Smith) Stapp, 1928.
Phytomonas citriputiale (C. O. Smith) Bergey et al., 1930.
Phytomonas syringae (van Hall) Bergey et al., 1930.

Fawcett, Horne and Camp (1923) determined by inoculations and comparisons of *Bact. citriputeale* and *Bact. citrarefaciens* that the two organisms are identical culturally and pathogenically and that blast and black pit are two manifestations of the same disease.

Smith (1926) states that results of his work indicate that "citrus blast, the avocado blemish, and the California lilac disease are closely related and probably are caused by the same organism." Cross inoculations with *Bact. citriputeale* and *Bact. citrarefaciens* gave identical lesions.

Bryan (1928) showed that the European and American lilac blights are identical and also states that *Bact. citriputeale* cannot be distinguished from *Bact. syringae* in culture or cross inoculations.

Smith (1928) made successful inoculations and reinoculations with *Bact. citriputeale, Bact. syringae* and *Bact. cerasi* on apricot, avocado, lemon, orange, lilac, poplar, ash, jasmine, tomato, pear and apple. The cultural characters of all three agreed with those of the lilac organism as given by Bryan (1928). He

states that the results of his studies indicate that all three organisms are closely related culturally and pathogenically but he does not suggest a change in nomenclature.

Fawcett, Horne and Camp (1923) reported that inoculations with *Bact. citriputeale* and *Bact. citrarefaciens* were not successful on cherry, apricot, pear and almond although lesions were produced on orange at the same time.

Savastano (1923) states that he believes *Bact. citriputeale* is the same organism imperfectly identified by Comes as *Bacillus gummis*.

Symptoms: On lilac—The first symptoms of the disease are brown water-soaked spots on the leaves and internodes of young shoots in early spring. These spots blacken and increase rapidly in size in rainy weather. Immature leaves blacken rapidly and completely while the spots on older leaves enlarge slowly and by coalescing blacken and kill large areas of the leaf blade. Infection on immature shoots spreads around the twig girdling it for several centimeters. The stem bends over at this lesion and the part above withers and dies. On mature stems the spots spread longitudinally to the petioles and kill the leaves but not the twig. Lesions also occur on peduncles and pedicels of the flower clusters and flower buds may be blackened. The bacteria attack primarily the parenchyma spreading through the intercellular spaces of the cortex, blackening and killing the cells and frequently forming cavities. Infection may spread through the vascular system causing wilting of the upper leaves and sunken blackened areas on the stem along the line of internal infection.

On lemons lesions develop during the spring months around wounds and first show as a slight darkening of the oil glands and then of the intermediate tissue. A distinct dark blue forms between diseased and healthy tissue. The spots are circular to oval in outline, depressed, 5–20 mm. in diameter and firm, reddish brown to brown or black. A reddish brown zone sometimes develops at the outer margin of the pits. Black discolored water-soaked areas develop on the leaves of citrus trees. Young leaves may drop off leaving twigs or branches bare or may lose their turgidity and hang to the tree. The blackened areas may spread down the petioles to the twigs and whole twigs may become blackened and shriveled. If the twigs are not actively growing small black areas may form at the bases of petioles over which brown blister-like scabs are formed when the leaves have fallen.

The organism invades the intercellular spaces and destroys the cells leaving large pockets filled with bacteria. Citrus blast, black pit, mal secco.

Hosts: *Atriplex hortensis, Chalcas exotica, Citrus aurantifolia, Citrus aurantium, Citrus grandis, Citrus limonia, Citrus sinensis, Coprosma baueri, Fagopyrum esculentum, Fraxinus floribunda* (S. P. I. 47687), *Jasminum primulinum, Lycopersicum esculentum, Persea americana, Populus nigra, Populus* sp., *Prunus armeniaca, Prunus mahaleb, Prunus* sp., *Pyrus communis, Quercus agrifolia, Quercus wislezenii, Syringa chinensis, Syringa persica, Syringa vulgaris*.

Geographical distribution: Poland, Netherlands, Germany, Italy, Sicily, Palestine, Australia, United States—Illinois, California, Washington.

Control: Careful pruning out of diseased twigs is the best method of control. Fawcett, Horne and Camp (1923) found that spraying citrus trees with Bordeaux mixture (5–5–50) the first of November would prevent a large part of the injury. Leaves and twigs should be thoroughly covered and they recommend the addi-

tion of 1 lb. of casein to the Bordeaux. Trees with a bushy compact type of growth are less liable to injury. Windbreaks protect the trees from injury. Methods of fertilization, irrigation and culture which insure good healthy growth of shoots and leaves, before fall sets in, are desirable.

Literature:

1891. Sorauer, P. Neue Krankheitserscheinung bei Syringa. Zeitschr. Pflanzenkr. 1: 186–188, 1891. This is the first published account of the disease as it occurred in Germany.

1899. Bos, Ritzema J. Eene bacteriënziekte der syringen. Tijdschr. Plantenziekten 5: 177–183, 1899. He found it in the Netherlands and considered it to be bacterial.

1902. van Hall, C. J. J. Bijdragen tot de kennis der bakterielle plantenziekten. (Doctor's thesis) Univ. of Amsterdam, 1902.

1905. Smith, E. F. Bacteria in relation to plant diseases 1: 63, 66, 1905.

1908. Güssow, H. T. New lilac leaf disease in England (*Pseudomonas syringae*). Gard. Chron. 44: 404–405, 1908. Bryan (1928) says it is quite improbable that he was dealing with the lilac disease of the Netherlands.

1909. Klebahn, H. Krankheiten des Flieders. Berlin, Gebr. Borntraeger 5–8, 1909.

1912. Klebahn, H. Grundzüge der Allgemeinen Phytopathologie Berlin, p. 106, 1912.

1913. Smith, C. O. Black pit of lemon. Phytopath. 3: 69, 1913. (Abstract.)

1916. Coit, J. E. Citrus blast—a new disease in California. Univ. California Journ. Agr. 3: 234–235, 1916. The disease is first described here on citrus leaves and twigs.

1917. Doidge, E. M. A bacterial spot of citrus. Ann. Appl. Biol. 3: 53–81, 1917. She gives a comparative table of *Bacillus citrimaculans, Bacterium citriputeale, Pseudomonas citri*.

1917. Hodgson, R. W. Citrus blast, a new bacterial disease. Mo. Bul. State Com. Hort. California 6: 229–233, 1917.

1918. Hodgson, R. W. Citrus blast. Quart. Bul. State Plant Bd. Florida 2: 123–130, 1918.

1919. Fawcett, H. S. Citrus blast. California Citrograph 5: 3, 1919.

1920. Smith, E. F. An introduction to bacterial diseases of plants, p. 670, 1920.

1921. Fawcett, H. S., and A. F. Camp. Citrus blast and black pit. California Citrogr. 6: 234, 1921.

1921. Savastano, L. Gommosi secca negli agrumi. Boll. R. Staz. Sper. Agrumic. e Fruttic. Acireale N. 41: 5–7, 1921.

1922. Fawcett, H. S. The relation of citrus blast to certain environmental factors. Phytopath. 12: 107, 1922. "The organism has a low optimum temperature for growth and infection and is dependent upon cool as well as moist weather condition and injuries for infection and development."

1923. Fawcett, H. S., W. T. Horne, and A. F. Camp. Citrus blast and black pit. California Agr. Exp. Sta., Tech. Paper 5: 1–24, 1923.

1923. Savastano, L. Delle epidemie italiane del mal secco negli Agrumeti, Albicoccheti, Ficheti, Noceti e Gelseti. Studio di Clinica Arborea. Ann. R. Staz. Sperim. di Agrumic. e Fruttic. Acireale 7: 89–176, 1923. *Ps. citriputeale* causes wilt or (mal secco) in Italy.

1922. Citrus blast and black pit. Report of the College of Agriculture and the Agricultural Experiment Station of the University of California 1st July, 1921 to 30th June, 1922: 72, 1922. Further work by Fawcett and Camp confirmed the identity of *Bacterium citrarefaciens* Lee with *Bact. citriputeale* Smith. Differences in symptoms are due to differences in climatic conditions.

1925. Brookes, R. St. John, K. Nain and M. Rhodes. The investigation of phytopathogenic bacteria by serological and biochemical methods. Journ. Path. and Bakt. 28: 203–209, 1925. See *Bacillus carotovorus*.

1925. Fawcett, H. S. Observations on bark diseases of citrus trees in Sicily. Phytopath. 15: 41–42, 1925.

1925. Savastano, L. Sulle cause aggravanti il mal secco negli agrumeti del versante orientale della Sicilia. Boll. R. Staz. Sperim. Agrumic. e Fruttic. Acireale 54: 7 pp., 1925. Recent outbreaks of "mal secco" are attributed to the use of citron stocks and new methods of irrigation.

1926. Carne, W. M. Citrus pit (*Pseudomonas citriputeale* C. O. Smith). Journ. Dept. Agric. Western Australia 2nd Ser. 3: 378–381, 1926. This is the first report from western Australia.

1926. Fawcett, H. S., and H. A. Lee. Citrus diseases and their control, pp. 293–304, 443–450, 1926.

1926. Lewcock, H. K. A citrus bacteriosis occurring in South Australia. Phytopath. 16: 80, 1926. (Abstract.)

1926. Smith, C. O. Blast of avocados—a bacterial disease. California Citrograph 11: 163, 1926.

1926. Smith, C. O. Similarity of bacterial diseases of avocado, lilac, and citrus in California. Phytopathology 16: 235–236, 1926.

1927. Bryan, M. K. Beef infusion versus beef extract media. Phytopath. 17: 413–414, 1927. Note. *Bact. syringae* is fluorescent on beef infusion peptone agar and shows a decided surface wrinkling.

1927. Garbowski, L. Choroby roślin uprawnych oraz drzew i krzewów leśnych i parkowych w wielkopolsce i na Pomorzu w. r. 1926 i 1927. Prace Wydz. Chorob Róslin w Bydgoszczy Państw. Inst. Naukow. Gospod. Wiejsk. No. 7: 54, (1929)? (French summary.) *Pseudomonas syringae* is reported on lilac from Poland.

1927. Laubert, R. Die Fliederseuche. Die Gartenwelt 31: 374–375, 1927.

1928. Bryan, M. K. Lilac blight in the United States. Journ. Agr. Res. 36: 225–235, 1928.

1928. Smith, C. O. A study of citrus blast and some allied organisms. Phytopath. 18: 952, 1928. (Abstract.)

1928. Stapp, C. Schizomycetes (Spaltpilze oder Bakterien). In Sorauer's Handbuch der Pflanzenkrankheiten 2 (fünfte auflage): 190–191, 1928.

1928. Newton, G. A. Department of Plant Pathology. Western Washington Agric. Exp. Sta. Bul. 10W: 22–23, 1928. *Bacterium syringae* has recently made its appearance in Washington.

1928. Reichert, I. On the investigation of citrus diseases in Palestine. Palestine Citrograph 1: 16–17, 1928. Blast is considered the most important disease in the nursery.

1929. Patel, M. K. Viability of certain plant pathogens in soils. Phytopath. **19**: 295–300, 1929.

1930. Bergey's Manual of Determinative Bacteriology, pp. 242, 244, 1930. (3rd. ed.)

Bacterium tabacum (Wolf and Foster) Wolf and Foster, 1918

Motile by one to six polar flagella; 0.5–0.75 x 1.4–2.8μ; no capsules; no spores; chains; Gram negative; not acid fast; aerobic; glycerin agar and potato agar colonies are grayish white, circular, raised, smooth, glistening, margin entire; gelatin liquefied; no diastatic action; no gas; acid from mannit, galactose, dextrose, sucrose; casein precipitated; nitrates not reduced; no indol; no ammonia; no hydrogen sulphide; thermal death point 46°–51°C.

Synonymy:

Bacterium tobacum Wolf and Foster, 1917.
Phytomonas tabaca (Wolf and Foster) Bergey et al., 1923.
Phytomonas tobacae (Wolf and Foster) Bergey et al., 1923.
Pseudomonas tabaci (Wolf and Foster) Stapp, 1928.

Symptoms: Infection occurs chiefly on the leaves. In the seed beds there may occur a wet rot stage among crowded plants. Leaf margins and tips of leaves show a rapidly advancing wet rot. Bud leaves of such plants are pale and slow in developing. This rot occurs in patches in the damper parts of the seed beds. On larger plants the first signs of the disease are circular yellowish green areas a sixth to a fifth of an inch in diameter. Within 24 hours minute dead brown specks appear in the centers of the spots and the yellow green halo becomes more prominent. During the next few days the dead center and the halo increase in size to form a spot a half inch or more in diameter, with a water-soaked border around the margin of the dead brown center. These spots may fuse, forming large irregular dead areas. Leaves affected on one side become twisted and distorted. In dry weather the tan to dark brown spots remain intact but under moist conditions spots become water-soaked and rot out giving the leaves a ragged appearance. White or light brown sunken spots $\frac{1}{8}$ to $\frac{1}{4}$ inch in diameter may occur on the stalks. The halo is not distinct but can be seen about some of the spots. Lesions occur as small dark irregular spots on the corolla and calyx and on the seed pods as water-soaked spots which later become brown and dead.

Hosts: *Lycopersicum esculentum, Nicotiana tabacum, Petunia hybrida, Phytolacca americana* (*decandra*), *Solanum melongena, Vigna sinensis.* Artificial infection by Johnson, Slagg and Murwin (1924) on species of 21 other families.

Geographical distribution: General throughout tobacco-growing regions of the Atlantic seacoast from Florida, Alabama and Georgia to Connecticut, Massachusetts, New Hampshire and southern Vermont and westward at least as far as Kentucky, Tennessee and Wisconsin; Rhodesia, S. Africa; Nyasaland; Argentine; Philippines; Greece; Germany; Bulgaria; France; Poland.

Control: Control measures should be based on elimination of the disease from the seed bed since nearly all field infection originates here. Seed should be selected from disease-free fields. Suspected seed should be treated by one of the following methods: 1:1,000 corrosive sublimate for fifteen minutes; 15 minutes in a solution of one ounce of formaldehyde to a pint of water, stirring constantly, washing until all odor of formaldehyde has disappeared and drying the seed as rapidly as possible at room temperature; silver nitrate 1:1,000 for fifteen minutes or two treatments of 5–10 minutes each. Either the seed should be planted on new soil or the old seed bed should be sterilized with steam at 100 lbs. pressure for 30 minutes or with 1–50 formalin at the rate of ½ gallon per square foot. All boards, sash, cloth, etc., should be drenched in 1–50 formalin. Plants in the seed bed should be dusted with copper-lime dust or sprayed with Bordeaux mixture at weekly intervals. Only plants from disease-free beds should be set out in the field. Infected plants and leaves should be removed and destroyed every few days. Fields should be kept clear of refuse from diseased plants. Anderson (1925) states that none of the 41 varieties of *Nicotiana tabacum* are resistant to wildfire. All varieties of *Nicotiana rustica* and *N. alata* tried and *N. repanda*, *N. nudicaulis*, and *N. attenuata* are highly resistant. When resistant species of *N. nudicaulis* and *N. alata* are crossed with *N. tabacum* the hybrids are resistant.

Literature:

1917. Wolf, F. A., and A. C. Foster. Bacterial leaf spot of tobacco. Science 46: 361–362, 1917.

1918. Wolf, F. A., and A. C. Foster. Tobacco wildfire. Journ. Agr. Res. 12: 449–458, 1918.

1919. Reinking, O. A. Philippine plant diseases. Phytopath. 9: 130, 1919.

1919. Wolf, F. A., and E. G. Moss. Diseases of flue-cured tobacco with suggestions for application of palliative, preventive and remedial measures. The Bul. of the North Carolina Dept. Agric. 40, No. 12: 24–34, 1919. They report the occurrence of the disease on flowers and seed pods. They also state that observations extending through three seasons show that the wildfire invariably begins in the plant bed, and is introduced into the field at time of transplanting.

1920. Chapman, G. H. Tobacco wildfire. Massachusetts Agr. Coll. Exten. Serv. Circ. 82: 1–7, 1920.

1920. Ganossis, B. Une maladie nouvelle aux plantations de tabac de Macedonie et de Thrace. Nea Fewudnia, 1920. From Sorauer P. Handbuch der Pflanzenkrankheiten 2 (fünfte auflage): 270, 1928.

1921. Chapman, G. H., and P. J. Anderson. Tobacco wildfire. Preliminary Report of Investigations. Massachusetts Agr. Exp. Sta. Bul. 203: 67–81, 1921.

1921. Fromme, F. D. Wildfire and angular spot. Rhodesia Agr. Journ. 18: 411–414, 1921. The disease was no doubt introduced into Rhodesia on seed from U. S. A.

1921. Fromme, F. D. and S. A. Wingard. Treatment of tobacco seed and suggested program for control of wildfire and angular-spot Phytopath. 11: 48–49, 1921. (Abstract.)

1921. Johnson, J. The relation of air temperature to certain plant diseases. Phytopath. **11**: 446–458, 1921.
1921. Taylor, H. W. Note. Rhodesia Agric. Journ. **18**: 411, 1921.
1921. Valleau, W. D. Wildfire and angular leaf-spot of tobacco. Univ. of Kentucky College of Agric., Extension Division Circ. 89: 3–16, 1921. Angular leaf-spots and wildfire spots are often hard to distinguish on ripe tobacco but this is never the case in the early part of the season.
1921. Wolf, F. A., and A. C. Foster. Studies on the physiology of some plant pathogenic bacteria. North Carolina Agric. Exp. Sta., Tech. Bul. 20: 1921. IV. Thermal death points of some bacterial plant pathogenes in relation to reaction of the medium, pp. 21–24. V. The fermentative activity of some plant pathogenic bacteria in relation to hydrogen-ion concentration, pp. 25–43, 1921.
1921. Wolf, F. A., and I. V. Shunk. Tolerance to acids of certain bacterial plant pathogenes. Phytopath. **11**: 244–250, 1921.
1922. Clinton, Geo. P., and F. A. McCormick. Wildfire of tobacco in Connecticut. Connecticut Agr. Exp. Sta. Bul. 239: 365–423, 1922. The disease was probably first seen in Connecticut in 1918 or 1919. They show that the organism may overwinter in tobacco refuse left in the fields and to a certain extent it may overwinter in soils.
1922. Conant, G. H. The wildfire disease of tobacco in Wisconsin. Wisconsin Dept. Agr. Bul. 52: 58–66, 1922.
1922. Evans, I. B. Pole. Tobacco wildfire. Journ. Dept. Agric. of Union S. Africa **4**: 57, 1922. Wildfire occurs in Rhodesia and the Transvaal.
1922. Fromme, F. C., and S. A. Wingard. Blackfire or angular leaf spot of tobacco. Virginia Agr. Exp. Sta. Tech. Bul. 25: 5–43, 1922.
1922. Johnson, J., and S. B. Fracker. Tobacco wildfire in Wisconsin. Wisconsin Univ., Agric. Coll. Bul. 348: 2–21, 1922. First observed in Wisconsin in June, 1922.
1922. Slagg, C. M. Preliminary report on a study of the wildfire disease of tobacco. Phytopathology **12**: 51–52, 1922. (Abstract.)
1922. Wolf, F. A. Wildfire of tobacco. North Carolina Agr. Exp. Sta. Bul. 246: 5–26, 1922. This account of the disease acknowledges errors in Wolf and Foster's first paper as to size of organism, number of flagella, aerobism, fermentation activities and thermal death point, errors already pointed out by others.
1922. Wolf, F. A. Studies on fermentation of rare sugars by plant pathogenic bacteria. Journ. Elisha Mitchell Sci. Soc. **38**: 12–13, 1922. *Bacterium tabacum* attacks manitol and galactose. *Bact. angulatum* does not.
1923. Anderson, P. J. Controlling tobacco wildfire in the seedbed. Phytopath. **13**: 59, 1923. (Abstract.)
1923. Anderson, P. J., and G. H. Chapman. Tobacco wildfire in 1922. Massachusetts Agr. Exp. Sta. Bul. 213: 1–27, 1923.

1923. Bergey's Manual of Determinative Bacteriology, pp. 185–186, 1923.

1923. Eyles, Frederick. Bacterial infection of tobacco seedbeds. Rhodesia Agr. Journ. 20: 693–694, 1923.

1923. Valleau, W. D. An important period in the life history of two bacterial organisms causing leaf-spots on tobacco. Phytopath. 13: 140–144, 1923.

1923. Wolf, F. A. Studies on the physiology of some plant pathogenic bacteria; VII Pectic fermentation in culture media containing pectin. Phytopath. 13: 381–384, 1923.

1924. Anderson, P. J. Overwintering of tobacco wildfire bacteria in New England. Phytopath. 14: 132–139, 1924. The writer concludes that the organism overwinters in covered leaves in barn, leaves on standing plants in field, on boards and dry fragments of pods.

1924. Cavadas, D. S. Le wildfire dans les plantations de tabac de Thrace et de Macédoine. Rev. Path. Vég. et d'Entom. Agric. 11: 236–242, 1924. First reported from Greece in 1920 but the identity of the disease was only recently established.

1924. Johnson, J. Experiments with dusting and spraying for the control of tobacco wildfire in seed-beds. Phytopath. 14: 50, 1924. (Abstract.)

1924. Johnson, J., and H. F. Murwin. Disinfection of tobacco seed against wildfire. Phytopath. 14: 50–51, 1924. (Abstract.) Silver nitrate seems to be an ideal disinfecting agent for tobacco seed. No seed injury follows its use.

1924. Johnson, J., C. M. Slagg, and H. F. Murwin. Host plants of *Bacterium tabacum*. Phytopathology 14: 175–180, 1924.

1924. Smee, C. Entomology. Mycological and bacterial work. Ann. Rept. Dept. Agric. Nyasaland Protectorate for 1923: 35–36, 1924.

1924. Thomas, H. E. Tobacco wildfire. Cornell Agr. Exp. Sta., Extens. Bul. 79: 1–7, 1924.

1924. Thomas, H. E. Tobacco wildfire and tobacco seed treatment. Phytopath. 14: 181–187, 1924.

1924. Valleau, W. D., and C. Hubbard. Angular leaf-spot and wildfire infection of tobacco plant beds by spitting. Phytopath. 14: 51, 1924. (Abstract.) "It is believed that chewing tobacco is the chief source of plant bed infection in Kentucky."

1924. Recommendations for the control of wildfire (revised). Connecticut Agr. Exp. Sta., Tobacco Sub-Sta. Bul. 4: 2 pp., 1924.

1925. Anderson, P. J. Susceptibility of *Nicotiana* species, varieties and hybrids to tobacco wildfire. Phytopath. 15: 77–84, 1925. None of the 41 varieties of *Nicotiana tabacum* showed any significant degree of resistance to wildfire. Tested varieties of *Nicotiana rustica*, *Nicotiana alata*, *Nicotiana repanda*, *Nicotiana nudicaulis*, *Nicotiana attenuata* are highly resistant. Fourteen other species vary in susceptibility.

1925. Brookes, R. St. John, K. Nain and M. Rhodes. The investigation of phytopathogenic bacteria by serological and biochemical methods. Journ. Path. and Bakt. 28: 203–209, 1925. See *Bacillus carotovorus*.

1925. Charlan, F. Las viruelas y rullas del Tabaco en la República Argentina. Min. Agric. Nac. (Buenos Aires) Secc. Prop. e Inform. Circ. 397: 1–4, 1925. First identified in Argentine in 1924. Widespread in Corriente, Salta, and Tucumán, also in Misiones.

1925. Gardner, M. W. Indiana plant diseases, 1923. Proc. Indiana Acad. Sci. 34: 309, 1925.

1925. Johnson, J., and H. F. Murwin. Experiments on the control of wildfire of tobacco. Wisconsin Agr. Exp. Sta. Res. Bul. 62: 1–35, 1925. In every case infection in the field could be traced to seed bed infection.

1925. Newton, A. C. Formaldehyde treatment for bacterial diseases of tobacco. Rhodesia Agric. Journ. 22: 861–862, 1925. Germination was somewhat retarded but not appreciably injured.

1926. Moore, E. S. D'Herelle's bacteriophage in relation to plant parasites. So. African Journ. Sci. 23: 306, 1926. (Abstract.) Working with *Bacterium tabacum* she found strong evidence that "there exists in the juice of diseased tobacco leaves an invisible agent, which is repressive to the growth of bacteria in culture."

1927. Kern, H. Ueber das auftreten einer in Ungarn bisher nicht beobachteten Tabakkrankheit im Jahre 1926. Angewandte Botanik 9: 451–458, 1927. He reports a disease of tobacco in Hungary which strongly resembles wildfire (*Bact. tabacum*) but the organism was not identified.

1927. Kotte, W. Der Bakterienbrand des Tabaks, eine für Deutschland neue Pflanzenkrankheit. Deutsch Landw. Presse. 54: 714–715, 1927. It is definitely stated here that *Bacterium tabacum* was isolated from tobacco leaves and reproduced typical symptoms.

1927. Meisner. Eine neue blatt-fleckenkrankheit am Tabak. Mitteilungen Deutschen Landwirt. Gesellsch. 42: 964–965, 1927.

1927. Bryan, M. K. Beef infusion versus beef extract media. Phytopath. 17: 413–414, 1927. (Note.) *Bact. tabacum* is fluorescent on beef infusion peptone agar.

1927. Cavadas D. S. Bacterial diseases of tobacco in connection with *Gnorimoschema heliopa* in Thessaly. Internat. Rev. Agr. 18: 1357–1358, 1927.

1927. Marchal, P., et E. Foëx. Rapport phytopathologique pour les années 1926–1927. Ann. Serv. des Epiphyties 13: 414–415, 439, 1927. Tobacco wildfire was prevalent in the Bas-Rhin and Chatillon.

1927. Stapp, C. Das "Wildfeuer" eine bakterielle Blattfleckenkrankheit des Tabaks. Nachrichtenbl. Deutsch. Pflanzenschutzdienst. 7: 115–118, 1927.

1927. 26th Ann. Rept. Bur. Agric. Philippine Islands for 1926: 65, 1927. The disease is reported for the first time from the Philippines.

1928. Kotte, W. Der Bakterienbrand des Tabaks als Samlingskrankheit. Deutsche Landw. Presse. 55: 525, 1928.

1928. Pateff, P. Wildfire, a new tobacco disease in Bulgaria. Bul. de la Soc. Bot. de Bulgarie 2: 39–42, 1928.

1928. Pateff, P. Wildfire, a new bacterial leaf spot disease on tobacco in Bulgaria. (In Russian, English summary.) Rev. Inst. des Recherches Agron. en Bulgarie 4 (No. 3): 101–112, 1928. Specimens in the herbarium of the Agr. Exp. Sta. at Sofia dated 1915 clearly show symptoms of the disease.

1928. Stapp, C. Schizomycetes (Spaltpilze oder Bakterien) in Sorauer's Handbuch der Pflanzenkrankheiten 2 (fünfte auflage): 266–271, 1928.

1928. Würtenberger, W. Der Bakterienbrand des Tabaks. Mitteil. Deutsch. Landwirtsch. Gesellsch. 43: 271–272, 1928.

1929. Hill, J. B. Migration of *Bacterium tabacum* through the leaf tissues of *Nicotiana tabacum*. Phytopath. 19: 97, 1929.

1929. Jankowska, K. O nowych dla Polski chorobach roślin uprawnych. Roczniki Nauk Rolniczych i Leśnych, Poznań. 21: 159–161, 1929. English summary. *Bacterium tabacum* is reported from Poland.

1929. Kochanovski, L. Étude sur la maladie de la *Nicotiana rustica*, nommée "riaboukha." In Russian. La Défense des Plantes, Leningrad 5: 609–612, 1929. The symptoms of the disease are similar to those of wildfire and may prove to be identical.

1929. Miller, M. S. Contribution à l'étude d'une maladie de la *Nicotiana rustica*, nommée "riaboukha." La Défense des Plantes, Leningrad 5: 601–608, 1929. In Russian.

1929. Patel, M. K. Viability of certain plant pathogenes in soils. Phytopath. 19: 295–300, 1929

1929. Riker, A J Studies on the influence of environment on infection by certain bacterial plant parasites. Phytopath. 19: 96, 1929.

Bacterium tolaasi (Paine) n. comb.

Motile by one to five polar flagella; 0.4–0.5 x 0.9–1.7μ; no capsules; Gram negative; not acid fast; aerobic, facultative anaerobic; bouillon agar colonies round, raised, wet-glistening, dirty greenish white, margins becoming lobed and spreading, rapid growing; good clouding in bouillon with pellicle, faint fluorescence, very viscid; gelatin liquefied; no gas; acid from glucose; no acid from lactose, sucrose, mannit; growth in Uschinsky's solution with thin pellicle, strong ring and no fluorescence; curd formed in milk and partially digested and whey strongly fluorescent; growth on potato cylinders at first white becoming faint yellow; slight diastatic action; trace of indol; ammonia produced; nitrates not reduced; optimum temperature 25°C.; thermal death point 49°–50°C.

Synonymy:

Pseudomonas tolaasi Paine, 1919.

Phytomonas tolaasi (Paine) Bergey et al., 1930.

Symptoms: Circular or irregular spots of a pale yellow color arise at or near the margin of the cap when it is about an inch in diameter. These enlarge rapidly, become a rich chocolate brown and may coalesce to form patches which may cover the entire cap and even the gills. The stalks also may be attacked. The infection penetrates only one to three millimeters in depth, the affected underlying tissue having a water-soaked appearance and a grey or yellowish grey color.

Host: *Agaricus campestris.*

Geographical distribution: Brentford, England; St. Paul, Minnesota.

Control: Fumigating beds with sulphur using about $1\frac{1}{2}$ pounds per thousand cubic feet of space has controlled the disease.

Literature:

1892. Constantin, M. J. La Goutte, Maládie du Champignon de Couche. Société de Biologie, Paris, Comptes Rendus 44: 197–200, 1892. Brown spots and sticky exudate appear on the cap and both are full of bacteria. No organism named or described.

1909. Matruchat, M. L. Des maladies du Champignon de Couche, la Goutte. La Culture des Champignon Comestible. No. 24, June, 1909. (From Tolaas 1915.)

1915. Tolaas, A. G. A bacterial disease of cultivated mushrooms. Phytopath. 5: 51–53, 1915.

1919. Paine, S. G. Studies in bacteriosis II. A brown blotch disease of cultivated mushrooms. Ann. Appl. Biol. 5: 206–219, 1919.

1925. Brookes, R. St. John, K. Nain, and M. Rhodes. The investigation of phytopathogenic bacteria by serological and biochemical methods. Journ. Path. and Bakt. 28: 203–209, 1925. See *Bacillus carotovorus.*

1930. Bergey's Manual of Determinative Bacteriology, p. 242, 1930. (3rd ed.)

Bacterium tonellianum Ferraris, 1926

Tonelli—0.75–1.0 x 1.9–3.5μ; opalescent to dirty white on gelatin; gelatin not liquefied.

Smith—Motile by one to three polar flagella; 0.5–0.6 x 1.5–2.5μ; no spores; no capsules; agar colonies gray, flat, circular, glistening, with somewhat undulate margins; gelatin not liquefied; opalescent to pale gray on potato dextrose agar; acid from dextrose and galactose; no gas; aerobic; milk partly cleared without coagulation; clouding in Cohn's solution; no growth in Uschinsky's; indol produced; thermal death point 51°C.

Synonymy: *Pseudomonas savastanoi* var. *nerii* C. O. Smith, 1928.

Symptoms: The disease occurs on the branches, herbaceous shoots, leaves and the ovary, petals and peduncles of the inflorescence but it does not occur on underground parts of the plants.

On the older branches more or less spherical tumors form which are soft or spongy and rough with projecting tubercles. They increase slowly in size and become dark-colored. Dark-colored areas or pockets containing numbers of bacteria occur within the tumor often near the healthy tissue.

On young shoots lesions take the form of longitudinal swellings with small secondary swellings or tubercles and longitudinal splitting of the stem tissue.

On the leaves small tumors or swellings develop on the veins and are surrounded by yellowed tissue. Infected young leaves often show curling, thickening of the leaf tissue, swelling of the margins and bending of the midrib.

Infected pistils are distorted and the petals remain attached for a long time. Young seed pods are shorter and thicker than normal and have aborted seeds. Seed pods infected when partly grown become curved and distorted but produce normal seed. Rogno, cancro, tubercolosi.

Hosts: *Nerium oleander, Olea europea, Adelia (Forestiera) acuminata, Chionanthus virginica.*

Geographical distribution: Italy, France, South Africa, California.

Control: Cut off infected parts, at least 15 cm. below the exterior signs of the disease, with sterile shears. The wounds should be protected with a fungicide and young parts sprayed with Bordeaux mixture.

Literature:

1904. Passerini, N. Sopra la "Rogna" del *Nerium oleander* L. Bul. Soc. Bot. Ital., 178–180, 1904. He describes the tubercles on oleander.

1905. Peglion, V. La rogna o tuberculosi del *Nerium oleander.* Atti R. Accad. Naz. Lincei Rend. Cl. Sci. Fis., Mat. e Nat. **14**: 462–463, 1905. He describes tubercles on oleander in Italy and isolated an organism but did not prove its pathogenicity.

1906. Smith, C. O. A bacterial disease of the oleander: *Bacillus oleae* (Arc.) Trev. Bot. Gaz. **42**: 301–310, 1906. He described the disease, isolated a bacterium and proved its pathogenicity on oleander and olive and studied its cultural characters. No inoculations were made at that time with the olive organism on oleander.

1908. Savastano, L. Sulla transmissibilità del bacillo della tubercolosi dell'olivo nell'oleandro. Bol. Arbor. Ital. **4**: 86–87, 1908. He made inoculations on oleander with pure cultures of the olive tubercle organism and with fragments of olive tubercles and concluded that the bacterial disease of the olive could not be transmitted to the oleander.

1908. Smith, E. F. Recent studies of the olive tubercle organism. U. S. Dept. Agric., B. P. I. Bul. 131: 25–43, 1908. 16 out of 16 inoculations on olive produced tumors. 18 sets of punctures on 6 oleanders did not produce a single tumor. Peglion's organism proved nonpathogenic to the oleander. His experiments and observations led him to believe the oleander disease was not due to the olive tubercle organism. He suggests that the oleander disease may be due to *Bact. tumefaciens.*

1909. Evans, I. B. Pole. Knot disease, *Bacillus oleae* Trev. Ann. Rep. Transvaal Dept. Agr. 1907–1908: 126, 1909. He reports the oleander disease as of frequent occurrence in the Transvaal and in Cape Colony.

1911. Smith, E. F., N. A. Brown and C. O. Townsend. Crowngall of plants; its cause and remedy. U. S. Dept. Agric., B. P. I. Bul. 213: 31–33, 34, 88, 1911. P. 31—They describe and illustrate successful inoculations of the oleander with *Ps. tumefaciens* which are similar in younger stages to young natural galls on oleander in California. In a footnote they state that the organism causing the California disease of oleander is probably not identical with *Ps. tumefaciens.* Artificial inoculations of the olive with *Ps. tumefaciens* gave negative results.

1912. Tonelli, A. Una bacteriosi del leandro (Rogna, o Cancro, o Tubercolosi del Leandro). Ann. R. Accad. D'Agric. di Torino **55**:

383–400, 1912. He isolated an organism in pure culture from the tubercles which on inoculation reproduced the disease. The organism is briefly described as follows: Opalescent to dirty white on gelatin, gelatin not liquefied, 1.9–3.5 x 0.75–1.0μ. His inoculations with oleander organism were negative on *Chrysanthemum frutescens*, but he obtained positive results with *Ps. tumefaciens* in chrysanthemum and oleander.

1913. Tonelli, A. Il Cancro del Leandro. Rivista di Agricoltura di Parma **19**: 18–21, 34–36, 51–52, 1913.

1915. Hariot, P. Le Chancre du Laurier-Rose. Bul. Soc. Path. Veg. France **2**: 38–40, 1915. He reports the disease from France and refers to work and views of Tonelli.

1916. Smith, C. O. Notes on oleander bacteriosis. Phytopath. **6**: 308, 1916. (Abstract.) This disease closely resembles the olive knot (*Bact. savastanoi*) and aerial galls of *Bact. tumefaciens* but he found certain differences between this and the above two organisms.

1922. Smith, C. O. Pathogenicity of the olive knot organism on hosts related to the olive. Phytopath. **12**: 271–278, 1922. He obtained no infection on oleander (*Nerium oleander*) with the olive organism *Bact. savastanoi*.

1926. Ferraris, T. Trattato di Patologia e Terapia Vegetale. 3rd ed. **1**: 104–106, 1926. He says Tonelli did not think the organism was *Bacterium tumefaciens* and could not assign it with certainty to *Bacillus oleae*. Therefore, until proof to the contrary, he (Ferraris) considers it a distinct species and names it *Bacterium Tonellianum* Ferraris.

1927. Ferraris, T., and G. Gaggero. La rogna dell'Oleandro. Curiamo le Piante **5**: 152, 1927.

1928. Smith, C. O. Oleander bacteriosis in California. Phytopath. **18**: 503–518, 1928. He studied the disease in California for a number of years and after repeated experiments and study of cultural characters of the organism came to the conclusion that it was a variety of the olive knot organism and gave it the name *Bacterium savastanoi* var. *nerii* n. var. He found that *Bact. savastanoi* could not be made to produce tubercles on oleander and that the tubercles produced on olive by the oleander organism differed in some respects from olive knots. He apparently was not aware of the fact that Ferraris in 1926 had named the organism as described by Tonelli.

Bacterium translucens Jones, Johnson, Reddy, 1917

Motile by one polar flagellum; 0.5–0.8 x 1.0–2.5μ; chains; no spores; capsules; Gram negative; not acid fast; aerobic; agar colonies wax yellow, round, smooth, glistening, margins entire; gelatin liquefied; ammonia produced; milk coagulated and cleared; acid from dextrose, lactose, sucrose, maltose, glycerin, mannit; no gas; nitrates not reduced; no diastatic action; slight indol production; moderate growth in Uschinsky's solution; no growth in Fermi's and Cohn's; optimum temperature about 26°C.; maximum 35°–36°C.; thermal death point 50°C.

Synonymy:

Pseudomonas translucens (Jones, Johnson, Reddy) Stapp, 1928.

Phytomonas translucens (Jones, Johnson, Reddy) Bergey et al., 1930.

Symptoms: Leaf lesions first appear as small watersoaked areas which enlarge longitudinally forming irregular translucent stripes which may extend the full length of blade and sheath and which turn yellowish to brownish. Blotch like lesions may also occur and may cause considerable portions of the leaf blade to shrivel and turn light brown. Under humid conditions exudate appears along the lesions as tiny clouded drops which harden into yellowish resinous granules or spread over the leaf surface as thin grayish films. Watersoaked lesions may also occur on the glumes and the kernels may become brown and more or less shrunken. If the flag leaf is attacked before the head emerges exudate may seal up the sheath so that the head cannot escape. If the heads emerge they may be variously bent and distorted and part of the grains blighted. Infection takes place through the stomata, the organisms spreading through the intercellular spaces. The parenchyma walls become disintegrated and long cavities result which are filled with bacterial slime.

Hosts: *Hordeum vulgare*, *Hordeum distichum*, *Hordeum hexastichum*.

Geographical distribution.—South Carolina, Texas, Arkansas, Iowa, Indiana, Wisconsin, Minnesota, North Dakota, South Dakota, Montana, Colorado, Idaho, Oregon, Canada.

Control: The use of seed from badly infected fields or localities should be avoided. It is thought that seed treatment with formalin (1–320) for two hours, or with mercuric chloride or hot water might prove effective in controlling the disease.

Literature:

1916. Jones, L. R., A. G. Johnson, and C. S. Reddy. A bacterial disease of barley. Phytopath. **6**: 98, 1916. (Abstract.)

1916. Jones, L. R., A. G. Johnson and C. S. Reddy. Bacterial blights of barley and certain cereals. Science (n.s.) **44**: 432–433, 1916.

1917. Jones, L. R., A. G. Johnson, and C. S. Reddy. Bacterial blight of barley. Journ. Agr. Res. **11**: 625–643, 1917.

1917. Jones, L. R., A. G. Johnson, and C. S. Reddy. Bacteria of barley blight seed borne. Phytopath. **7**: 69, 1917. (Abstract.)

1924. Reddy, C. S., J. Godkin, and A. G. Johnson. Bacterial blight of rye. Journ. Agr. Res. **28**: 1039–1040, 1924.

1928. Sanford, G. B. Cereal diseases in Alberta in 1927. Scientific Agric. **8**: 464, 1928. (Abstract of paper read at 9th annual meeting at Winnipeg December, 1927.) He reports what appears to be *Bacterium translucens* on barley.

1928. Stapp, C. Schizomycetes (Spaltpilze oder Bakterien). In Sorauer's Handbuch der Pflanzenkrankheiten **2** (5): 22–23, 1928.

1930. Bergey's Manual of Determinative Bacteriology, p. 241, 1930. (3rd ed.)

Bacterium translucens secalis, Reddy, Godkin, Johnson, 1924

Identical with *Bacterium translucens* and *Bacterium translucens undulosum* both in morphological and physiological characters. Very feeble diastatic action.

Synonymy: *Pseudomonas translucens* var. *secalis* (Reddy, Godkin, Johnson) Stapp, 1928.

Symptoms: This organism causes blotch-like and stripe-like water-soaked lesions on leaves, with conspicuous exudate.

Host: *Secale cereale.*

Geographical distribution: Illinois, Wisconsin.

Literature:

1924. Reddy, C. S., Jas. Godkin, and A. G. Johnson. Bacterial blight of rye. Journ. Agr. Res. **28**: 1039–1040, 1924.

1928. Stapp, C. Schizomycetes (Spaltpilze oder Bakterien). In Sorauer's Handbuch der Pflanzenkrankheiten **2** (fünfte auflage): 23–24, 1928.

Bacterium translucens var. undulosum Smith, Jones, Reddy, 1919

See *Bacterium translucens* for characters of organism.

Synonymy: *Pseudomonas translucens* var. *undulosa* (Smith, Jones, Reddy) Stapp, 1928.

Symptoms: This organism causes yellow translucent stripes on leaves, water-soaked to black stripes on culms and longitudinal more or less sunken dark stripes or spots on the glumes. Bacteria ooze to the surface in tiny drops which dry to yellow beads. The kernels when attacked are shriveled and honey-combed with bacterial pockets. In severe infections the heads are dwarfed.

Hosts: (natural) *Triticum aestivum*; (artificial) *Hordeum vulgare, Secale cereale, Triticum spelta.*

Geographical distribution: Mississippi Valley and Great Plains States, Montana, Idaho, Russia, China, France.

Control: All shriveled kernels containing bacterial cavities should be removed from seed wheat. The disease may be controlled by dipping the seed for 10 minutes in 1:1,000 $CUSO_4$ followed by milk of lime and finally rapid drying but Braun (1919, 1920) found that a better method was that of soaking the seed for 10 minutes in water, keeping it damp for 6 hours and then dipping for 10 minutes in a 1:400 formalin solution, draining and covering for six hours, then drying over night and planting.

Literature:

1906. Heald, F. D. New and little-known plant diseases in Nebraska. Science **23**: 624, 1906. A bacterial blight of wheat leaves was common in the breeding plot at the experiment station.

1916. Jones, L. R., A. G. Johnson, and C. S. Reddy. Bacterial blights of barley and certain other cereals. Science **44**: 432–433, 1916.

1917. Smith, E. F. A new disease of wheat. Journ. Agr. Res. **10**: 51–54, 1917.

1917. Smith, E. F. Black chaff of wheat. U. S. Dept. Agr., B. P. I. Plant Disease Survey Bul. 1: 40, 1917.

1918. Smith, E. F. Black chaff of wheat. U. S. Dept. Agr., B. P. I. Plant Disease Survey Bul. 2: 98–99, 1918.

1919. Braun, H. Presoaking as a means of preventing seed injury due to disinfectants and of increasing germicidal efficiency. Science **49**: 544–545, 1919.

1919. Smith, E. F., L. R. Jones, and C. S. Reddy. The black chaff of wheat. Science (n.s.) **50**: 48, 1919.

1920. Braun, H. Presoak method of seed treatment: a means of preventing seed injury due to chemical disinfectants and of increasing germicidal efficiency. Journ. Agr. Res. **19**: 363–392, 1920.

1920. Smith, E. F. An introduction to bacterial diseases of plants, pp. 56, 70–72, 1920.

1925. Jaczewski, A. A. (Bacterial diseases of cereals.) Bul. Appl. Bot. and Plant-Breeding, Leningrad, 14: 377–385, 1925. (Russian with English abstract.) The writer records for the first time the presence in European Russia of black chaff due to *Bact. translucens* var. *undulosum*. He found the disease in samples dating as far back as 1910 from widely separated provinces and on a sample from Sunpan, China, dated 1893.

1926. Smith, E. F. Black chaff of wheat in Russia. Science **63**: 305–307, 1926.

1927. Foëx, M. Station centrale de pathologie végétale de Paris. Rapport sur les travaux en 1926 et 1927. Ann. Serv. des Epiphyties **13**: 485, 1927.

1928. Millasseau, J. Note préliminaire sur une maladie bactérienne du Blé. Rev. Path. Veg. et D'Ent. Agric. **15**: 279–284, 1928. Black chaff of wheat was prevalent in 1928 in the vicinity of Paris and in Brie and in southern France. It is also reported to have been observed in Brittany in 1913 and at Grignon in 1916.

1928. Sanford, G. B. Report of the Dominion Laboratory of Plant Pathology for Alberta. Report of the Dominion Botanist for 1927, Div. Botany, Canada Dept. Agric. 114, 1928. Traces of black chaff were collected at Westlock, Lacombe, Youngstown, Claresholm.

1928. Stapp, C. Schizomycetes (Spaltpilze oder Bakterien). In Sorauer's Handbuch der Pflanzenkrankheiten 2 (5): 23–24, 1928.

1929. Godkin, James. Physiological studies of *Bacterium translucens* and *Bacterium translucens* var. *undulosum*. Phytopath. **19**: 99, 1929. (Abstract.)

1929. Haskell, R. J., and Jessie I. Wood. Diseases of cereal and forage crops in the United States in 1928. U. S. Dept. Agric., B. P. I., The Plant Disease Reporter Sup. 71: 275–276, 1929.

1929. Hocquette, M. Une nouvelle maladie du Blé dans le nord de la France: le "black chaff." Compt. Rend. Soc. Biol. (Paris) **100**: 271–272, 1929. Leaf lesions as well as the black lesions on the glumes were observed.

Bacterium trifoliorum Jones, Williamson, Wolf, McCulloch, 1923

Motile by one to four unipolar flagella; 0.4–1.0 x 1.2–3.0μ; chains; no spores; capsules; Gram negative; aerobic; nutrient agar colonies grayish white, glistening, margins entire, convex or slightly umbonate, circular; growth on potato agar white, butyrous, abundant, surface rugose at center with tendency to contours at periphery; gelatin not liquefied; nitrates not reduced; feeble diastatic action;

no gas; acid from dextrose and sucrose; milk curdled but not digested; blood serum not liquefied; no growth in Cohn's solution; clouding in Fermi's and Uschinsky's solutions with pellicles and blue green fluorescence; ammonia produced; optimum temperature 26° in bouillon, 18°–21° in agar; maximum 35°C.; minimum below 3°C.; thermal death point 48°–49°C.

Synonymy:

Phytomonas trifoliora (Jones, Williamson, Wolf, McCulloch) Burkholder, 1926.

Pseudomonas trifoliorum (Jones, Williamson, Wolf, McCulloch) Stapp, 1928.

Symptoms: This disease may appear at any time throughout the growing season. The most conspicuous symptoms occur on the leaves but stems, stipules, petioles and flower pedicels are also attacked. Lesions first appear as minute translucent dots on the lower leaf surface, which enlarge and become more or less angular. The centers turn black and the margins remain water-soaked. Large irregular dead areas may be formed. Centers of old lesions may fall out, and badly spotted leaves may yellow and fall prematurely. A milk white bacterial exudate dries to a thin film on the lower surface. The organism enters chiefly through the stomata and occupies intercellular spaces.

Hosts: (natural) *Trifolium alexandrinum, Trifolium hybridum, Trifolium incarnatum, Trifolium medium, Trifolium pannonicum, Trifolium pratense, Trifolium repens, Trifolium repens latum;* (artificial) *Phaseolus lunatus macrocarpus, Stizolobium deeringianum, Trifolium pratense perenne.*

Geographical distribution: District of Columbia, Maryland, Virginia, North Carolina, Indiana, Wisconsin, Iowa.

Literature:

1921. Jones, L. R., and M. M. Williamson. Bacterial leaf spot of red clover. Phytopath. 11: 50, 1921. (Abstract.)

1923. Jones, L. R., M. M. Williamson, F. A. Wolf, and L. McCulloch. Bacterial leafspot of clovers. Journ. Agr. Res. 25: 471–490, 1923.

1924. Ciferri, R. Esperienze sulla propagazione della batteriosi fogliare del Trifoglio e sulla lotta mediante la sterilizzazione parziale del suolo. Staz. Sperim. Agrar. Ital. 57: 165–177, 1924. Although he did not isolate the organism he thinks the disease is due to *Bacterium trifoliorum.*

1925. Brookes, R. St. John, K. Nain and M. Rhodes. The investigation of phytopathogenic bacteria by serological and biochemical methods. Journ. Path. and Bakt. 28: 203–209, 1925. See *Bacillus carotovorus.*

1926. Burkholder, W. H. A new bacterial disease of bean. Phytopath. 16: 922, 1926.

1928. Mains, E. B. Observations concerning clover diseases. Proc. Indiana Acad. Sci. 37: 359–360, 1928. *Bacterium trifoliorum* caused heavy infection in 1925 and 1926 and considerable defoliation of red clover.

1928. Stapp, C. Schizomycetes (Spaltpilze oder Bakterien). In Sorauer's Handbuch der Pflanzenkrankheiten 2 (5): 177, 1928.

Bacterium tritici (Hutchinson) n. comb.

Motile by one polar flagellum; 0.8 x 2.4–3.2μ; agar colonies bright yellow becoming orange, convex, round, margins entire, glistening, moist, opaque in center, opalescent at edges, agar browned; gelatin not liquefied; no gas; acid from glucose, lactose; litmus reduced; slight yellow growth on potato; no hydrogen sulphide; nitrate reduced; ammonia produced; thermal death point about 50°C.

Synonymy:

Pseudomonas tritici Hutchinson, 1917.

Phytomonas tritici (Hutchinson) Bergey et al., 1930.

See *Aplanobacter agropyri*, *Aplanobacter rathayi*.

Symptoms: Diseased plants first show a wrinkling of the lower and twisting of the central leaves accompanied by the exudation of a bright yellow slime or gum over all affected parts. This gum forms sticky layers between the glumes and between the stems and sheath and interferes with the growth of the plant so that the stem becomes distorted. Abnormally small slender yellow heads may be formed. As the gum hardens it becomes deeper yellow. The disease occurs in patches in the field in badly drained areas and does not appear until the crop is nearing maturity. Tandu.

Host: *Triticum aestivum.*

Geographical distribution: India, Egypt, Australia.

Control: Only healthy seed from districts where the disease does not occur should be used. Diseased plants should be burned and fields should be well drained and cultivated. Carne (1926) recommends crop rotation to get rid of eelworms.

Literature:

1917. Hutchinson, C. M. A bacterial disease of wheat in the Punjab. Memoirs Dept. Agric. India., Bacteriological Series **1**: 169–175, 1917.

1925. Fahmy, T. E., and T. E. Mikhail. The bacterial disease of wheat caused by *Pseudomonas tritici* (Hutchinson). Agric. Journ. Egypt, New Annual Series 1923, **1**: 64–72, 1925. Inoculations with bacteria alone were not successful but they did succeed when both bacteria and nematodes were used at the same time.

1926. Carne, W. M. Earcockle (*Tylenchus tritici*) and a bacterial disease (*Pseudomonas tritici*) of wheat. Journ. Dept. Agr. Western Australia **3** (Ser. 2): 508–512, 1926. Bacteria are carried into the plants by eelworms.

1930. Bergey's Manual of Determinative Bacteriology, p. 240, 1930. (3rd ed.)

Bacterium tumefaciens Smith and Townsend, 1907

Motile by polar flagella; 0.4–0.8 x 1.0–3.0μ; chains; no spores; Gram negative; not acid fast; aerobic; nutrient agar colonies small, circular, somewhat raised, glistening, white, translucent; streaked on agar from agar growth smooth, glistening; streaked on agar from peptone bouillon growth is thin, wrinkled and dull; gelatin not liquefied; nitrates not reduced; no gas; acid from dextrose and sucrose; no diastatic action; curd formed in milk but not digested; indol, hydrogen sul-

phide and ammonia produced; on +15 peptone bouillon there is more or less pellicle and a whitish rim of stringing gelatinous threads; growth in Uschinsky's solution scant, in Cohn's scant or absent; litmus frequently reduced; optimum temperature 25°–30°C.; maximum 37°C.; minimum 0°C.; thermal death point about 51°C.

Synonymy:

Bacillus ampelopsorae Trevisan, 1889. Trevisan, without making inoculations or any cultural studies, based his name on the work of Corvo and Cuboni, neither of whom made pure culture inoculations. Cavara in 1897 made pure cultures of the right organism and with it successful inoculations and accepted Trevisan's name for the organism with which he worked. Smith (1911) says, "Inasmuch as this name was given without inoculations or study of cultures, and as various bacteria occurring in the tumors are indistinguishable microscopically, and the saprophytes often more abundant than the parasite, and particularly as the parasitic organism does not, as far as we know, congregate in zoogloeae masses in cracks or lacunae of the dead tissue in the manner described for this organism, his name is not here used."

Pseudomonas tumefaciens (Smith and Townsend) Stevens, 1913.

Phytomonas tumefaciens (Smith and Townsend) Bergey et al., 1923.

Polymonas tumefaciens (S. B. T.) Lieske, 1928.

See *Bacillus rosarum* Scalia.

See *Clostridium persicae tuberculosis* Cavara.

See *Bacillus populi* Brizi, 1907.

Symptoms: This is primarily a disease of the parenchyma. It begins in meristematic tissue causing a rapid proliferation of cells and the formation of more or less spherical to somewhat convoluted soft or hard overgrowths or tumors. These tumors may occur on any part of the root or shoot and may be larger than the root or shoot which bears them. Open cavities in the plant tissue are not produced. The disease progresses slowly stunting the plant and finally killing it.

Hosts: Species of the following families and genera: *Salicaceae—Salix, Populus; Juglandaceae—Juglans, Pterocarya, Carya; Fagaceae—Castanea; Moraceae—Ficus, Humulus; Polygonaceae—Rumex; Chenopodiaceae—Beta; Caryophyllaceae—Dianthus; Ranunculaceae—Clematis; Lauraceae—Persea; Cruciferae—Matthiola, Brassica, Raphanus; Resedaceae—Reseda; Crassulaceae—Sedum, Bryophyllum; Rosaceae—Rosa, Cydonia, Crataegus, Amygdalus, Rubus, Malus, Pyrus, Prunus; Leguminosae—Pisum, Trifolium, Medicago; Geraniaceae—Pelargonium; Tropaeolaceae—Tropaeolum; Rutaceae—Citrus; Euphorbiaceae—Ricinus, Manihot; Anacardiaceae—Schinus, Mangifera; Celastraceae—Euonymus; Balsaminaceae—Impatiens; Vitaceae—Vitis, Ampelopsis (Parthenocissus); Malvaceae—Althaea, Hibiscus; Sterculiaceae—Sterculia; Passifloraceae—Passiflora; Begoniaceae—Begonia; Cactaceae—Opuntia; Myrtaceae—Eucalyptus; Oenotheraceae—Fuchsia; Umbelliferae—Daucus, Pastinaca; Ericaceae—Vaccinium, Arbutus; Ebenaceae—Diospyros; Oleaceae—Forsythia, Ligustrum; Apocynaceae—Allamanda, Nerium; Polemoniaceae—Phlox; Labiatae—Salvia, Coleus; Solanaceae—Lycopersicum, Solanum, Nicotiana; Caprifoliaceae—Lonicera; Compositae—Chrysanthemum, Calendula, Helianthus.*

Geographical distribution: The disease is practically universal in its distribution. It occurs in North America (U. S. and Canada), Europe, South America, Asia, South Africa, Australia and New Zealand.

Control: The disease may be controlled by careful inspection of nursery stock and condemnation of diseased trees and shrubs and by rotation of crops using immune hosts such as corn and oats until the soil is again free from the bacterium. For control of stem end and center rot of tomato see *Bact. malvacearum.*

Literature:

1853. Fabre, E., and F. Dunal. Observations sur les maladies regnantes de la vigne. Bul. Soc. Centr. d'Agric. de l'Hérault. 40: 46, 1853. This is probably the first published description of crowngall of grape.

1869. Köhler, J. M. Der Weinstock und der Wein. Raude (Kropf, Grind, Schorf), 205–206, 1869. Knotty growths come out on old wood near the ground. These have been attributed to low temperature in winter or spring.

1875. Du Breuil, M. A. Les vignobles et les arbres à fruits a cidre, pp. 228–229, 1875. He gives a drawing of a gall and considers late frost the cause.

1879. Garovaglio, S., and A. Cattaneo. Studi sulle dominanti malattie dei vitigni. Della rogna dei vitigni. Archivio del Laboratorio di Botanica Crittogamica de Pavia 2–3: 248–252, 1879.

1882. Goethe, R. Les exostoses de la vigne. La Vigne Américaine **6**: 136–144, 1882. The only remedy for this disease is good drainage.

1882. Planchon, J. E. Les exostoses fungoïdes de la vigne connues sous le nom de broussins. La Vigne Américaine **6**: 110–117, 1882.

1882. Seillan, J. Le broussin ou exostose. La Vigne Américaine **6**: 117–120, 1882. "Broussin" appears in spring on vine stocks as whitish tumors or excresences which by fall become woody and dented brown knobs or tumors. They prevent the flow of sap and cause the decay of the stock. He says they are due to late frosts and dampness.

1885. Corvo, A. Sur le rôle des bacilles, dans les ravages attributés au *Phylloxera vastatrix.* Compt. Rend. Acad. Sci. (Paris) **101**: 528–530, 1885. He maintains that tuberculosis of the vine is due to bacteria which may be transmitted by insects.

1886. Sorauer, P. Der Krebs (Grind) des Weinstockes. Handbuch der Pflanzenkrankheiten **1**: 414–416, 418, 1886.

1886. Sorauer, P. Kropfmaser. Handbuch der Pflanzenkrankheiten **1**: 731–734, 1886. Probably the same disease on apple and pear in Germany. crowngall

1886. Sorauer, P. Wurzelkropf. Handbuch der Pflanzenkrankheiten **1**: 737–743, 1886.

1889. Cuboni, G. Sui bacteri della rogna della vite. Atti R. Accad. Naz. Lincei Rend. Cl. Sci. Fis., Mat. e Nat. **5**: 571–573, 1889. He found bacteria in the tubercles of the vine but did not mention any cultures or inoculations.

1889. Galloway, B. T. Black knot of the grape. U. S. Dept. Agric., Bot. Div. Bul. 8: 63, 1889. He describes a form of crowngall on grape vine canes which he considers the same as broussins, krebs, tubercoli.

1891. Comes, O. *Bacillus ampelopsorae*, Trev., Batterio della rogna della vite. Crittogamia Agraria **1**: 522–525, 1891.

1891–1894. Smith, E. F. Stem and root tumors. Journ. Mycology **7**: 93–94, 1892; 376–377, 1894; 1891–1894. "This was the first work on the disease in the Dept. of Agric."

1893. Viala P. Gelées de printemps.—Broussins. Les Maladies de la vigne, 3d ed., 478–490, 1893.

1894. Cavara, F. Apercu sommaire de quelques maladies de la vigne parues en Italie en 1894. Revue Internationale de Viticulture e D'Oenologie **1**: 447–449, 1894. "First part deals with broussins. He says he has recently isolated a bacterium which when inoculated into the vine causes this disease, i.e., a tuberculosis not unlike that of the olive. Dr. Smith says he thinks this is his first announcement of bacterial nature of the grape gall."

1894. Probable cure for root knot. California Fruit Grower **15**: 481, 1894.

1894. Zacharewicz, E. Les broussins dans les vignes de Vaucluse. Revue Internat. de Viticulture **1**: 119–120, 1894.

1896. Bailey, L. H. Root galls. New York (Cornell) Agr. Exp. Sta. Bul. 117: 425–434, 1896.

1896. Lataste, F. Contagiosité et prophylaxie de la maladie tuberculeuse de la vigne. Actes de la Société Scientifique du Chili **6**: 74–77, 1896. Also in Compt. Rend. Acad. Sci. (Paris) **123**: 200–202, 1896.

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1896. Woodworth, C. W. Crown-knot. Rept. Agr. Exp. Sta. of Univ. of California for 1894–1895: 231–232, 1896.

1897. Cavara, F. Intorno alla eziologia di alcune malattie di piante coltivate. Staz. Sperim. Agrar. Ital. Modena, **30**: 483–487, 1897. Colonies on gelatin flat, mother-of-pearl color. Gelatin not liquefied. Aerobic, 1.5–2 x 0.5μ. He describes successful inoculation experiments. From these inoculations he reisolated the same mother-of-pearl color colonies which were used for inoculation. He accepted the name *Bacillus ampelopsorae* Trev. for this organism.

1897. Selby, A. D. Some diseases of orchard and garden fruits. Ohio Agr. Exp. Sta. Bul. 79: 127, 139, 1897.

1897. Taft, L. R. Crowngall. 10th Ann. Rept. Michigan Agr. Exp. Sta. for year ending June 30, 1897: 96–97, 1897.

1898. Cavara, F. Tumori di natura microbica nel *Juniperus phoenicea*. Bullettino della Societa Botanica Italiana, Dicembre, 241–250, 1898. Smith, Brown and Townsend (1911) say: "In 1898 Cavara also described a tumor from juniper, which he attributed to bacteria. Two species were isolated, a micrococcus liquefying gelatin slowly, and a rod which grew as a white mass and rapidly

liquefied gelatin. In this case he made inoculations, but not on the same species of juniper and did not obtain any positive results with either organism."

1898. Selby, A. D. Preliminary report upon diseases of the peach. Ohio Agr. Exp. Sta. Bul. 92: 208–217, 1898. He proved the infectious nature of the peach gall.

1900. Cavara, F. La Tubercolosi della vite. Italia Agricola N. 23, 15 Dec., 1900.

1900. Forbes, S. A. The crowngall as a nursery pest. Trans. Illinois State Hort. Soc. 34: 136–151, 1900.

1900. Stewart, F. C., F. M. Rolfs and F. H. Hall. A fruit disease survey of western New York in 1900. Geneva, New York Agr. Exp. Sta. Bul. 191: 300–301, 1900. Attention is here first called to hairy-root in this country.

1900. Toumey, J. W. An inquiry into the cause and nature of crowngall. Arizona Agric. Exp. Sta. Bul. 33: 7–64, 1900. He proved the infectious nature of almond gall. He found a myxomycete *Dendrophagus globosus* in galls on almond trees and considered it the cause of the abnormal outgrowths. He made the first extensive study of the disease and showed its pathogenic nature.

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1903. Paddock, W. Crowngall. Colorado Agric. Exp. Sta. Bul. 86: 3–7, 1903. He recommends covering wounds with a water paste of copper sulphate 2 parts, iron sulphate 1 part and lime (unslaked) 3 parts.

1904. Popenoe, E. A. The crowngall in Kansas. Rept. Kansas State Hort. Soc. for 1902–1903, 27: 134–137, 1904.

1903. Clinton, G. P. Report of the Botanist. Crowngall. Rept. Connecticut Agr. Exp. Sta. 27: 299, 309, 338, 346, 354, 1904.

1904. Sandsten, E. P. Crowngall. Rept. Wisconsin State Hort. Soc. 34: 132–137, 1904.

1905. Hedgcock, G. G. Some of the results of three years experiments with crowngall. Science 22: 120–122, 1905.

1906. Garcia, F. European grapes. Observations on the crowngall. New Mexico Agr. Exp. Sta. Bul. 58: 19, 28–29, 1906.

1906. Hedgcock, G. G. The crowngall disease of the grapevine. New Mexico Agr. Exp. Sta. Bul. 58: 30–31, 1906.

1906. Hedgcock, G. G. The crowngall and hairy-root diseases of the apple tree. U. S. Dept. Agric., B. P. I., Bul. No. 90: part II, 15–17, 1906.

1906. Von Schrenk, H., and G. G. Hedgcock. The wrapping of apple grafts and its relation to the crowngall disease. U. S. Dept. Agric., B. P. I. Bul. 100: part II, 1906.

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1907. Smith, E. F., and C. O. Townsend. Ein Pflanzentumor bakteriellen Ursprungs. Central. f. Bakt. 20: 89–91, 1907.

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1908. Hedgcock, G. G. Some stem tumors or knots on apple and quince trees. U. S. Dept. Agri., B. P. I., Circ. 3, 1908. He describes and figures hairy root.

1908. Jaeger, J. Ueber Kropfmaserbildung am Apfelbaum. Zeitschr. f. Pflanzenkr. 18: 257–272, 1908.

1908. Sorauer, P. Der Krebs (Grind) des Weinstockes. Handbuch der Pflanzenkrankheiten 1: 594–596, 1908.

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1912. Smith, E. F. The staining of *Bact. tumefaciens* in tissue. Phytopath. (Notes) **2**: 127–128, 1912. Stained with gold chlorid the bacteria seem to occupy only a small proportion of the cells of the gall.

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1925. Riker, A. J. The influence of temperature and of previous infection on the development of crowngall. Phytopath. **15**: 45, 1925. (Abstract.) Well developed galls were produced between 14° and 28°C.

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1925. Sherbakoff, C. K. Effect of soil treatment with sulphur upon crowngall in nursery apple trees. Phytopath. **15**: 105–109, 1925.

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1925. Wormald, H., and N. H. Grubb. Field observations on the crowngall of nursery stocks. Ann. Rept. East Malling Res. Sta. 1924: 122–125, 1925.

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1926. Brown, N. A. A stem-end and center rot of tomato caused by various unrelated organisms. Journ. Agric. Res. 33: 1009–1024, 1926. The disease can scarcely be detected on the outside of the fruit, while the central core, including portions of the seeds, is a mass of hard, dark tissue. Causes losses in shipments of green tomatoes. Organisms producing decay readily: *Bacterium malvacearum* E. F. S., *Bacterium marginale* Brown, *Bacterium tumefaciens* Smith and Townsend, *Bacterium savastanoi* E. F. S., *Bacterium campestre* E. F. S., *Bacterium viridilividum* Brown, and fungi. Organisms which produce the disease with difficulty: *Bacterium citri* Hasse, *Bacterium vitians* Brown, *Bacillus coli communis* Esch., *Bacillus mycoides* Flügge. See Brown, N. A. A new bacterial disease of tomato fruits. Science 62: 12–13, 1925.

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1926. Hatton, R. G., H. Wormald, and A. W. Witt. On "burr-knots" of fruit trees. Journ. Pomol. and Hort. Science 5: 195–204, 1926. They agree with Brown and with Swingle that they have no connection with crowngall due to *Bact. tumefaciens*.

1926. Israilsky, W. P. Bakteriophagie und Pflanzenkrebs. Centralb. f. Bakt. 67: 236–242, 1926. He attributes the small numbers of bacteria in galls and the difficulty of isolating them to the presence of bacteriophage.

1926. Israilsky, W. P. Phanomen a'Herelle und Pflanzenkrebs. Ber. Bact. Agron. Stat. Moskau, **24**: 143–157, 1926. (Russian with German summary.)

1926. Küster, E. Regenerationserscheinungen an Bakteriengallen. Flora N. F. **20**: 179–197, 1926.

1926. La Verruga de la Vina. Min. Agric. Nac. (Buenos Aires), Secc. Prop. e Inform. Circ. 565: 3 pp., 1926. "Verruga" of the vine in Argentina is said to be the same as rogna, tobercoli, krebs, crown knot, etc., due to crowngall. A list of highly resistant varieties is given. Since the disease is more frequent on surface irrigated vineyards, ridge irrigation is recommended.

1926. Magrou, J. Sur l'anatomie du cancer des plantes ou crowngall. Compt. Rend. Acad. Sci. (Paris) **183**: 986–988, 1926.

1926. Magrou, J. Le *Bacterium tumefaciens* dans les tissus du cancer des plantes. Compt. Rend. Acad. Sci. (Paris) **183**: 804–806, 1926.

1926. McClintock, J. A. Aerial galls of quince. Phytopath. **16**: 78, 1926. (Abstract.)

1926. Melhus, I. E. Crowngall of apple nursery stock. Jour. Econ. Entom. **19**: 356–365, 1926. He concludes that mechanical injuries and grafting are responsible for a large percentage of crowngalls on nursery apple trees.

1926. Muncie, J. H. Hairy root of apple seedlings. Phytopath. **16**: 78, 1926. (Abstract.)

1926. Muncie, J. H. The effect of crowngall on young apple and peach trees and longevity of *Bacterium tumefaciens* in the soil. Phytopath. **16**: 79, 1926. (Abstract.)

1926. Muncie, J. H. A study of crowngall caused by *Pseudomonas tumefaciens* on rosaceous hosts. Iowa State Coll. Journ. Sci. **1**: 67–117, 1926.

1926. Oppenheimer, H. R. Verhütung und Heilung krebsartiger Pflanzen Geschwülste. Angewandte Botanik **8**: 8–29, 1926.

1926. Patel, M. K. An improved method of isolating *Pseudomonas tumefaciens* Sm. and Town. Phytopath. **16**: 577, 1926.

1926. Riker, A. J. Studies on the influence of some environmental factors on the development of crowngall. Journ. Agr. Res. **32**: 83–96, 1926.

1926. Riker, A. J. Cytological studies of crowngall tissue. Amer. Journ. Bot. **14**: 25–37, 1926.

1926. Riker, A. J., and G. W. Keitt. Studies of crowngall and callus overgrowths on apple grafts. Phytopath. **16**: 78, 1926. (Abstract.)

1926. Riker, A. J., and G. W. Keitt. Studies of crowngall and wound overgrowth on apple nursery stock. Phytopath. **16**: 765–808, 1926.

1926. Rivera, V. Saggi di rodioterapia vegetale. Boll. R. Staz. Pat. Veg. **6**: 337–345, 1926.

1926. Rivera, V. Effet des rayons X sur les tissus vegetaux normaux et pathologiques. Ann. Inst. Pasteur **40**: 614–657, 1926. 12–25

minutes exposure was found to effect the reduction and necrosis of the neoplasms formed by *Bact. tumefaciens* on inoculated plants.

1926. Rivera, V. Transformazioni indotte dai raggi X in tessuti tumorali vegetali. Riv. di Biol. **8**: 1–15, 1926.

1926. Rivera, V. È necessaria la ferita del tessuto per la produzione di tumori da *B. tumefaciens* su vegetali? Boll. della Accad. Pugliese di Scienze **1**: 4 pp., 1926.

1926. Rosen, H. R. Morphological notes together with some ultra-filtration experiments on the crowngall pathogene, *Bacterium tumefaciens.* Mycologia **18**: 193–205, 1926.

1926. Sibilia, C. Il batteriofago nella patologia vegetale. Boll. R. Staz. Pat. Veg. **6**: 200–209, 1926. A transmissible lytic principle is stated to have been demonstrated in *Bacterium tumefaciens.*

1926. Smith, E. F. Recent cancer research. Amer. Nat. **60**: 240–256, 1926.

1926. Smith, E. F., and A. J. Quirk. A begonia immune to crowngall: With observations on other immune or semi-immune plants. Phytopath. **16**: 491–508, 1926. Supposed to be immune owing to the acidity of their juices.

1926. Waite, M. B., and E. R. Siegler. A method for the control of crown-gall in the apple nursery. U. S. Dept. Agr. Circ. 376: 8 pp., 1926. They recommend control by seedling selection; ten minutes immersion of seedlings and scions in Semesan 1 in 400, (or about 1oz. to 3 gallons); five seconds immersion of grafts, wrapped in raffia or muslin, in the same solution; cool storage of grafts and 5 seconds immersion in fresh Semesan solution before planting; frequent disinfection of implements.

1926. Teutschländer and F. Kronenberger. Ueber Versuche mit *Bacterium tumefaciens.* Zeitschr. f. Krebsforsch. **23**: 177–182, 1926. Attempts to produce tumors in mice and rats with *Bacterium tumefaciens* gave negative results.

1927. Apple trees and "hairy root" investigation. Fruit World of Australasia **28**: 423, 1927. There is no evidence that crowngall is a serious disease in Australasian apple orchards.

1927. Arnaudi, C. À propos de quelques expériences sur l'immunité acquise des végétaux. Rev. Path. Veg. et Ent. Agric. **14**: 103–112, 1927. An attempt at immunization was made with geraniums infected with *Bacterium tumefaciens*; the author concludes that his results justify the belief that artificial immunization of plants is possible.

1927. Bechhold, H., and L. Smith. Das Tumefaciens-Plastin. Zeitschr. f. Krebsforsch. **25**: 97–104, 1927. The filtrate of *Bact. tumefaciens* passed through a Chamberland L5 filter, was capable of producing tumors on carrot slices.

1927. Brown, N. A. Sweet pea fasciation, a form of crowngall. Phytopath. **17**: 29–30, 1927.

1927. Bunting, R. H. Diseases of cocoa and measures for their control. Proc. First West African Agric. Conf., 86–97, 1927. Tumors on stems and branches are thought to be due to *Bacterium tumefaciens.*

1927. Dauvergne, J., et L. Weil. Le cancer experimental du *Sedum spectabile.* Compt. Rend. Soc. Biol. (Paris) **97:** 815–816, 1927. Inoculations with *Bact. tumefaciens* on *Sedum spectabile, Sedum telephium, Sedum aizoon, Sedum album* and *Sedum acre* resulted in grayish, irregular tumors of 3.5 cm. on all aerial organs.

1927. Esmarch, F. Der Bakterienkrebs und seine Bekämpfung. Die Kranke Pflanze. **4:** 185–188, 1927.

1927. Guyton, T. L., and W. A. McCubbin. Rose insects and diseases. Pennsylvania Dept. Agr. Bul. 10: 1–17, 1927. They give directions for the preparation and application of fungicides.

1927. Israilsky, W. P. Bakteriophagie und Pflanzenkrebs. Centralb. f. Bakt. **71:** 302–311, 1927. The bacteriophage was found to exert a marked inhibitory effect on the development of the organism in the plants.

1927. Kauffmann, F. Zur Erzeugung von Pflanzengeschwülsten durch die aus Mäusecarcinomen isolierten. T-Bakterien. Zeitschr. f. Krebsforsch. **24:** 260–262, 1927.

1927. Kauffmann, F. Weitere Erfahrungen mit Tumefaciens-Stämmen. Zeitschr. f. Krebsforsch. **26:** 18–20, 1927.

1927. Lieske, R. Untersuchungen über die als Mauke odor grind bezeichnete erkrankung der Weinreben. Arb. Biol. Reichsanst. f. Land- und Forstwirtsch. **15:** 261–270, 1927. Vine disease, known in Germany as "mauke" or "grind," in France as "broussin" or "broussins," in Italy as "rogna" or "malattie dei tubercoli," in United States as "black knot," is also recorded from Holland, Spain, Chile, Australia. He isolated organisms which proved to be the same as *Bacterium tumefaciens.* Inoculations were positive on vines, beets, tomatoes, pelargoniums, willows, poplars, *Crataegus, Solanum* sp., Virginia creeper (*Ampelopsis* (*Parthenocissus*) *quinquefolia*), and the organism was reisolated.

1927. Link, G. K. K., and K. L. Hull. Smoothness and roughness and spontaneous agglutination of *Bacterium citri, Bact. medicaginis* var. *phaseolicola, Bact. phaseoli sojense,* and *Bact. tumefaciens.* Bot. Gaz. **73:** 412–419, 1927. Roughness in colony form in *Bact. tumefaciens* seems to be correlated with ready spontaneous agglutination and smoothness with less agglutinability.

1927. Magrou, J., and M. Magrou. Radiations émises par le *Bacterium tumefaciens.* Rev. Path. Vég. et Ent. Agric. **14:** 244–246, 1927.

1927. Magrou, J. Remarques sur la bacteriologie et l'anatomie du crown-gall. Rev. Path. Vég. et Ent. Agric. **14:** 45–50, 1927.

1927. Magrou, J. Recherches anatomiques et bacteriologiques sur le cancer des plantes. Ann. Ist. Pasteur. **41:** 785–801, 1927.

1927. Patel, M. K. Strains of *Pseudomonas tumefaciens.* Phytopath. **17:** 46, 1927 (Abstract.)

1927. Riker, A. J. Cytological studies on crowngall tissue. Amer. Journ. Botany **14**: 25–37, 1927.

1927. Rivera, V. È necessaria la ferita del tessuto per la produzione di tumori da "*B. tumefaciens*" su vegetali. Boll. Accad. Pugliese di Sci. **1**: 6, 1926. Abs. in Bul. Inst. Pasteur 25: 564–565, 1927.

1927. Rivera, V. Depressioni ed esaltazioni dell' accrescimento in neoplasmi vegetali sperimentali irradiati. Riv. Biol. Milano **9**: 62–70, 1927.

1927. Robinson, W. Some features of crowngall in plants in reference to comparisons with cancer. Proc. Roy. Soc. Med. **20**: 53–56, 1927.

1927. Smith, E. F. Tumours, cysts, pith-bundles, and floral proliferations in *Helianthus*. Mem. Nat. Acad. Sci. Washington **22**: 1–5, 1927.

1927. Stapp, C. Der bakterielle pflanzenkrebs und seine beziehungen zum tierischen und menschlichen krebs. Ber. Deutsch. Bot. Ges. **45**: 480–504, 1927. He found that various strains of *Bacterium tumefaciens* show distinct serological differences but nevertheless advocates retention of the specific name for the entire group.

1928. Arnaudi, C. Nuove espérienze sulla vaccinazione delle piante. Riv. Pat. Veg. **18**: 161–168, 1928.

1928. Banfield, W. M. Studies on the life history of the crowngall organism. Phytopath. **18**: 128–129, 1928. (Abstract.) The organism may overwinter in the soil in Wisconsin.

1928. Giovanni, A. Sarcoma a cellule fusate in un pesce iniéttato con il *Bacterium tumefaciens*. Arch. Sci. Med. Torino **52**: 481–495, 1928.

1928. Hill, J. B. The method and rate of migration of *Bacterium tumefaciens* in tomato. Phytopath. **18**: 129, 1928. (Abstract.)

1928. Kauffman, F. Über die Veranderlichkeit von Tumefaciensbacillen. Zeitschr. f. Krebsforsch. **26**: 330–332, 1928.

1928. Kauffman, F. Zur Tumefaciensfrage. Zeitschr. f. Krebsforsch. **28**: 109–120, 1928.

1928. Levine, M. Studies in crowngall transplants. Phytopath. **18**: 130, 1928. (Abstract.)

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lineum gave good results in the "mauke" disease of the vine (*Bacterium tumefaciens*).

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Bacterium vasculorum (Cobb) R. G. Smith, 1902

Motile by one polar flagellum; 0.3–0.5 x 0.6–1.5μ; no spores; no long chains; Gram positive (E. F. Smith), (Gram negative Grieg Smith); aerobic; nutrient agar colonies slow growing, pale yellow, glistening, rather flat; gelatin liquefaction slight or none; moderate clouding in beef bouillon, sometimes with whitish rim and rarely with pellicle; growth in Uschinsky's solution absent or feeble; no growth in Cohn's; no gas; nitrates not reduced; no acids; litmus not reduced; casein not precipitated in litmus milk; optimum temperature about 30°C.; maximum between 35° and 37.5°C.; thermal death point 49°–50°C.

Synonymy:

Bacillus vascularum Cobb, 1893.

Bacillus sacchari Spegazzini, 1895. (Janse (1891) has already used this name. Since Smith (1914) says it should probably be referred to *Bacterium vascularum* it is given as a synonym rather than renamed.) (Spegazzini says his organism is much like *Bacillus marcescens*.)

Bacterium vascularum (Cobb) Migula, 1900 (Migula's *Bacterium* was nonmotile).

Pseudomonas vascularum (Cobb) E. F. Smith, 1901.
Bacillus vascularum (Cobb) Migula (used by Ferraris), 1913.
Phytomonas vascularum (Cobb) Bergey et al., 1923.

Symptoms: This is primarily a vascular disease characterized by dwarfing of the plants, longitudinal white striping of the leaves, dying of the tops, decay of the terminal buds, reddening of the vascular bundles and formation of a yellow slime or gum in the bundles of stems and leaves. This yellow slime also fills the cavities formed in the soft parenchyma tissue below the terminal bud. Leaf sheaths around the terminal bud may be stuck together with the yellow gum and prevent normal development of the growing shoot which becomes bent and twisted and sometimes pushes out sidewise or growth may cease and lateral shoots develop. Cobb's disease of sugar cane, Bacterial gummosis.

Host: *Saccharum officinarum.*

Geographical distribution: Australia, Fiji, Mauritius, Brazil, Colombia, Porto Rico, St. Kitts, St. Lucia, Martinique, Guadeloupe.

Control: The use of resistant varieties offers the only practicable means of control. No immune varieties are known but there are a number of highly resistant varieties which can be grown without damage if there are no susceptible varieties in the vicinity. The disease can be eradicated by growing resistant varieties and rigidly excluding susceptible varieties. Lightly infected crops frequently recover in periods of dry weather. The disease may be controlled even when moderately susceptible varieties are grown if rigid seed selection and clean cultivation methods are practiced. (North, 1929.)

Literature:

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1893. Cobb, N. A. Plant diseases and their remedies. Diseases of the sugar cane. Agric. Gazette N. S. Wales **4**: 777–798, 1893. His inoculations were made by direct transfer of yellow slime.

1894. Bonâme, P. Rapport sur la maladie de la canne. Rev. Agric. e Jour. de la Chambre d'Agric. de l'Ile Maurice. 8 ann. No. 8: 178–187, 1894. He reports Cobb's disease from Mauritius.

1894. Palmares. Cane disease in Pernambuco. The Sugar Cane **26**: 555, 1894.

1895. Cobb, N. A. The cause of gumming in sugar cane. Agric. Gaz. New South Wales **6**: 683–689, 1895. Smith, 1914, says "The cane disease was produced, apparently at least, by means of his *Bacillus vascularum*, but the inoculations were too few to be very conclusive."

1895. Spegazzini, C. La gangrena humeda o polvillo de la cana de azucar en Tucuman. La Plata June 15, 1895.

1900. Migula, W. System der Bakterien **2**: 512, 1900.

1901. Smith, E. F. The cultural characters of *Pseudomonas hyacinthi*, *Ps. campestris*, *Ps. phaseoli*, and *Ps. stewarti*—four one-flagellate yellow bacteria parasitic on plants. U. S. Dept. Agric., Div. Veg. Phys. and Path. Bul. 28: 153, 1901.

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1904. Smith, E. F. Ursache der Cobb'schen Krankheit des Zuckerrohrs. Centralb. f. Bakt. **13**: 729–736, 1904.

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1913. Ferraris, T. I parassiti vegetali delle piante coltivate od utile. 1913.

1914. Smith, E. F. Bacteria in Relation to Plant Diseases **3**: 3–71, 1914. (See for detailed discussion of the disease.)

1914. Smith, E. F. Bacteria in Relation to Plant Diseases **3**: 88, 1914. Smith received a culture of *B. sacchari* from Spegazzini but inoculations gave negative results.

1915. Groenewege, J. De gomziekte van het suikerriet veroorzaakt door *Bacterium vascularum* Cobb. Mededeel. van het Proefstation voor de Java-Suikerindustrie. Arch. Suikerindus. Ned. Indie, 23 pp., 1915. He considers the Java and Australian gum diseases identical.

1917. Groenewege, J. De gomziekte van het suikerriet en hare bestrijding. Mededeel. Proefst. voor de Java Suikerind. Landbank. ser. 1917, no. 6. Archief voor de Suikerindustrie in Ned. Indie., pp. 597–638, 1917. Never but once did he find bacterial cavities in the soft top of the diseased cane and thinks these are not a sign of the disease.

1918. Johnston, J. R. Diseases of sugar cane in tropical and subtropical America, especially the West Indies. West Indian Bulletin 16: 275–308, 1918.

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1920. Matz, J. La gummosis de la caña de azucar. Estac. Expt. Insular Porto Rico Circ. 20: 7 pp., 1920.

1922. Matz, J. Gumming disease of sugar cane. Jour. Dept. Agr. Porto Rico **6**: 5–21, 1922.

1923. Bergey's Manual of Determinative Bacteriology, pp. 179–180, 1923.

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1926. Chardon, C. E. "La gomosis," una epidemìa grave de la caña en Antioquia [Gumosis, a serious disease of cane in Antioquia (Colombia)]. Esc. Sup. Agr. y Med. Vet. Medellin, Colombia Circ. No. 1: 21 pp., 1926.

1926. Cottrell-Dormer, W. Cane pests and diseases. Queensland Agric. Journ. **25**: 45–47, 1926. Gumming disease due to *Bacterium vascularum* is decreasing due to the use of Q. 813 and increased attention to drainage.

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1927. Bell, A. F. Sugar cane diseases of North America and the West Indies. Queensland Agric. Journ. **27**: 102–103, 1927. Also in Australian Sugar Journal **18**: 601–207, 1927.

1927. Chardón, C. E., and R. A. Toro. Plant disease notes from the central Andes. Phytopath. **17**: 147–153, 1927.

1927. Cook, M. T. Experiencias con la gomosis de la caña de azúcar. Rev. de Agric. Puerto Rico **18**: 281, 1927. He gives the results of variety tests for resistance to *Bacterium vascularum*.

1928. Cook, M. T. The gummosis of sugar cane. Journ. Dept. Agric. Porto Rico **12**: 143–179, 1928.

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1928. Cook, M. T. Sugar cane gummosis. The Ref. Book Sugar Ind. of the World **6**: 72–73, 1928. He lists varieties of sugar cane in the order of their susceptibility to gummosis.

1928. Kelly, N. L., and G. Wilson. Cane pests and diseases. Queensland Agric. Journ. **29**: 272–275, 1928.

1928. Shepherd, E. F. S. La gommose de la canne à sucre. La Rev. Agric. de L'Ile Maurice, 1928: 173–176, 1928.

1928. (Walters, E. A.) Report of the Agricultural Department, St. Lucia 1927: 11, 1928.

1929. Ashby, S. F. Gumming disease of sugar cane. Tropical Agriculture **6**: 135–138, 1929. He compares the organism isolated on St. Kitts with the Australian organism.

1929. Bell, A. F. A key for the field identification of sugar cane diseases. Queensland Bureau of Sugar Experiment Stations, Div. Path., Bul. 2: 19–20, 1929.

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1929. North, D. S. The bacterial-vascular diseases of sugar cane. Facts about Sugar 24: 880–881, 1929.

1929. Williams, C. H. B. La gommose de la canne: son apparition à la Guadeloupe. Journ. Stat. Agron. Guadeloupe. 7: 106–111, 1929. This is the first report of the disease from Guadeloupe although it has probably been present for several years. Variety Ba. 11569 is generally attacked and B. H. 10(12), S. C. 12(4) and G. 119 are resistant.

Bacterium vesicatorium Doidge, 1920

Motile by one polar flagellum; ave. 0.6–0.7 x 1.0–1.5μ; chains; capsules; no spores; aerobic; Gram positive (Doidge), Gram negative (Gardner and Kendrick); not acid fast; beef agar colonies circular, semi-translucent, Naples yellow; growth on potato copious, yellow, spreading, butyrous to rather viscid; beef bouillon faintly clouded, with straw yellow ring and slight pellicle; gelatin and blood serum liquefied; no growth in Uschinsky's and Cohn's solutions; light clouding in Fermi's with yellow very viscid ring; milk coagulated and casein slowly peptonized (Doidge), milk digested without coagulation (Gardner and Kendrick); slow diastatic action; no gas; acid from dextrose, levulose, sucrose, lactose, galactose, glycerin, dextrin (Doidge), acid from dextrose, sucrose, lactose (Higgins), no acid from carbohydrates (Gardner and Kendrick); nitrates not reduced; no indol; optimum temperature about 30°C. (Doidge), 27°C. (Gardner and Kendrick); maximum 40°C.; minimum 5°C.; thermal death point 56°C. (Doidge), 49°–50°C. (Gardner and Kendrick).

Synonymy:

Bacterium exitiosum Gardner and Kendrick, 1921.
Pseudomonas exitiosa Gardner and Kendrick, 1921.
Phytomonas exitiosa (Gardner and Kendrick) Bergey et al., 1923.
Pseudomonas vesicatoria (Doidge) Stapp, 1928.
Phytomonas vesicatora (Doidge) Bergey et al., 1930.
See *Bact. briosii.*

Symptoms: Lesions on leaves are at first small water-soaked dots which become irregularly circular with yellowish translucent borders. The centers become brown to black, sunken and later parchment-like. Spots when numerous may coalesce and form irregular discolored streaks along the veins or margins. Edges and tips of leaves may become dead and dry and break away giving the leaves a ragged appearance. Heavily infected leaves turn yellow or brown and young leaves become distorted and die. The organism enters through the stomata of the leaves and multiplies in the intercellular spaces. Fruit lesions may occur at any point on the surface and first appear as small brown or black raised dots or blisters with narrow water-soaked margins. These enlarge from 1–3 mm. to form slightly elevated, blackened, superficial scabs with irregularly lobed margins and water-soaked halos. The central tissue becomes brown, corky and scab-like and the central portion may become so sunken that the lesions resemble pits or craters. A sticky exudate may ooze out. Blotch-like scabby areas may result from coalescence but there is no marked malformation or cracking of fruit. Lesions on cotyledons are small, sunken, silvery spots which turn darker in color. Lesions on stems, petioles and rachis are elongated and blackened and may cause death of leaflets. Cankers on older parts of the stem

are at first irregular, dark green, water-soaked areas which become corky, slightly raised, and roughened and cracked longitudinally. Fruit infection takes place through wounds, leaf infection through stomata. Bacteria fill the intercellular spaces and push up the epidermis. Host cells collapse and cavities are formed which are filled with bacteria. Scab, small pox, bacterial spot, black scab, canker.

Hosts: *Capsicum annuum* (4 types), *Datura stramonium* var. *tatula*, *Hyoscyamus niger*, *Hyoscyamus aureus*, *Lycium chinense*, *Lycium halimifolium*, *Lycopersicum esculentum* (73 varieties), *Lycopersicum pimpinnellifolium*, *Nicotiana rustica*, *Physalis minima*, *Solanum dulcamara*, *Solanum nigrum*, *Solanum rostratum*, *Solanum tuberosum*.

Geographical distribution: South Africa, New York, Pennsylvania, Tennessee, Georgia, Florida, Indiana, Illinois, Michigan, Iowa, Missouri, Kansas, Texas, Canada.

Control: Doidge (1921) recommends selection of resistant varieties, seed sterilization with formalin or mercuric chloride, a long crop rotation and destruction of diseased fruits and plants at the end of the season. Gardner and Kendrick (1921) recommend seed treatment in 1–3,000 corrosive sublimate solution for five minutes and washing for 10–15 minutes in running water. A hot water treatment at 50°C., for ten minutes is also recommended. The organism is carried on the surface of the seed.

Literature:

1912. Heald, F. D., and F. A. Wolf. A plant disease survey in the vicinity of San Antonio, Texas. U. S. Dept. Agr., B. P. I. Bul. 226: 42, 1912. They were the first to report a bacterial leafspot of pepper from Texas.

1918. Coons, G. H. Michigan Plant Disease Survey for 1917. Michigan Acad. Sci. Rep. 20: 446, 1918.

1918. Coons, G. H., and R. Nelson. Plant diseases of importance in the transportation of fruits and vegetables. Amer. Ry. Perishable Freight Assn. Circ. 473A: 48, 1918. They were the first to determine the bacterial nature of the disease.

1918. Sherbakoff, C. D. Bacterial spot of pepper. Rept. Florida Agr. Exp. Sta. for year ending June 30, 1917: 79R–83R, 1918. He isolated and proved the pathogenicity of a yellow organism.

1918. McCubbin, W. A. The diseases of tomato. Canada Agr. Exp. Farms Bul. Ser. 2, No. 35: 15, 1918. He reports what appears to be the same disease.

1920. Doidge, E. M. A tomato canker. Journ. Dept. Agr. So. Africa 1: 718–721, 1920.

1921. Doidge, E. M. A tomato canker. Ann. Appl. Biol. 7: 407–430, 1921.

1921. Gardner, M. W., and J. B. Kendrick. Bacterial spot of tomato. Journ. Agr. Res. 21: 123–156, 1921.

1921. Gardner, M. W., and J. B. Kendrick. Bacterial spot of tomato. Phytopath. 11: 55, 1921. (Abstract.)

1921. Gardner, M. W., and J. B. Kendrick. Tomato bacterial spot and seed disinfection. Indiana Agr. Exp. Sta. Bul. 251: 2–15, 1921.

1922. Higgins, B. B. The bacterial spot of pepper. Phytopath. 12: 501–516, 1922. He describes the organism in detail and says it is very similar to *Bact. vesicatorium* and *Bact. exitiosum* but differs in important physiological reactions.
1923. Bergey's Manual of Determinative Bacteriology, p. 183, 1923.
1923. Gardner, M. W., and J. B. Kendrick. Bacterial spot of tomato and pepper. Phytopath. 13: 307–315, 1923.
1926. Weber, G. F., and G. B. Ramsey. Tomato diseases in Florida. Florida Agric. Exp. Sta. Bul. 185: 85–87, 1926. The disease is almost entirely limited to the west coast trucking section, causing 2 per cent loss from spotting of the fruit.
1928. Gardner, M. W. Indiana Plant Diseases, 1926. Proc. Indiana Acad. Sci. 37: 423–424, 1928. Bacterial spot of tomato (*Bact. vesicatorium*) was more abundant than any year since 1919.
1928. Stapp, C. Schizomycetes (Spaltpilze oder Bakterien). In Sorauer's Handbuch der Pflanzenkrankheiten 2 (fünfte auflage): 259–262, 1928.
1930. Bergey's Manual of Determinative Bacteriology, p. 241, 1930. (3rd. ed.)

Bacterium viciae (Uyeda) Nak.?

Actively motile by two to four polar flagella; 0.5–0.8 x 1.2–2.0μ; no spores; Gram positive; facultative anaerobe; gelatin colonies pale white, glistening, raised, finally turning brown; in alkaline media colonies become green; gelatin not liquefied; milk coagulated and cleared and becoming yellow-green; no gas; growth on steamed potato moist, viscid, white becoming brownish cream; nitrates not reduced; no hydrogen sulphide; thermal death point 49°C.

Synonymy: *Pseudomonas viciae* Uyeda, 1915.

Symptoms: Leaf lesions first appear as small deep red spots. These enlarge to 0.3–0.5 inches in diameter, become irregularly circular to elliptical, the center turns light brown and the margin becomes deep red and slightly raised. A large part of the leaf may be covered and the leaf turns brown. Stem lesions are elongated and blue red, and the epidermis comes off showing the black discoloration underneath.

Hosts: *Brassica rapa, Daucus carota, Ipomoea batatas, Vicia faba.*

Geographical distribution: Japan, Korea.

Literature:

1915. Takimoto, S. Studies on the leaf burn disease of *Vicia faba.* Journal Plant Protection Soc. Japan 2: 846–851, 1915. (In Japanese.)
1928. Hara, S. (A Thesaurus of Plant Diseases), p. 55, 1928. He gives *Bacterium ~~oryzae~~* (Uyeda and Ish.) Nak. Where and when the genus was changed has not been determined.

Bacterium vignae Gardner and Kendrick, 1923

Motile by one to five bipolar flagella; 0.44–0.66 x 1.1–2.34μ; no spores; no capsules; Gram negative; nutrient agar colonies round, raised, glistening, grayish white; gelatin liquefied; growth on potato cylinders rapid, abundant, grayish

white, somewhat iridescent, smooth, glistening; milk cleared without coagulation, pale greenish yellow in color, and the liquid viscid or gelatinous; litmus reduced; nitrates not reduced; ammonia produced; no gas; acid from dextrose and sucrose; no diastatic action; no indol; growth in Fermi's and Uschinsky's solutions with formation of greenish-yellow pigment; no growth in Cohn's; blood serum liquefied; optimum temperature 27°C.; maximum below 35°C.; minimum between 3° and 9°C.; thermal death point 49°–50°C.

Synonymy:

Bacterium viridifaciens Tisdale and Williamson, 1923.

Phytomonas vignae (Gardner and Kendrick) Bergey et al., 1923.

Pseudomonas vignae Gardner and Kendrick, 1923.

Pseudomonas viridifaciens Tisdale and Williamson, 1923.

Phytomonas viridifaciens (Tisdale and Williamson) Bergey et al., 1925.

Symptoms: On cow peas leaf lesions are at first small, circular, sunken dots, water-soaked or greasy and later claret-brown in color. Larger lesions are irregularly circular or lobed with buff centers surrounded by maroon or claret-brown margins and about a mm. in diameter. In large lesions the centers may be bleached and dry with claret-brown borders. In old lesions the centers may dry, crack and fall out. Linear lesions may extend along the veins for 4–6 centimeters. On young growing leaves lesions may cause distortion, curling and tearing and vein lesions may cause curving and crinkling. Small claret-brown lesions may occur on the stipules. Stem and petiole lesions are more or less oval, 1–5 mm. long, victoria lake in color. The center is sunken and there may be water-soaked tissue above and below. Large sunken lesions are formed on epicotyls and hypocotyls of seedlings. Pod lesions are irregularly circular, 1–8 mm. in diameter, morocco red, claret brown, maroon or victoria lake in color. Larger lesions have sunken centers and water-soaked borders. Infections on young pods cause constriction and bending of the pod and the distal portion may fail to enlarge. Lesions may penetrate to the seed causing stunting, shriveling and discoloration. In seedlings infections may pass through the vascular bundles into the veins of the first leaf causing reddish-brown discoloration of the bundles and yellowing or wilting of the first leaves. In extreme cases the entire seedlings may be stunted or wilt and die.

On lima bean leaf lesions first appear as small brown points on the upper surface. Spots on the lower surface are depressed and have lighter colored margins. As the spots enlarge the centers dry out and turn straw-colored while the margins remain a glistening purplish red. Single spots are 1–3 mm. in diameter but if they coalesce the centers usually fall out giving the leaves a ragged appearance. Curling and distortion of young leaves may occur. Reddish-brown streaks also occur on veins and petioles, stems and pods. A straw-colored exudate appears on stem and pod lesions. When peduncles are attacked and girdled blossoms and young pods are shed. Pod lesions are at first small brown spots with water-soaked halos. Infection may penetrate to the seed. Stem and petiole infection may extend to the vascular tissue but does not progress far.

Hosts: *Desmodium canescens*, *Dolichos lablab*, *Phaseolus angularis*, *Phaseolus limensis*, *Phaseolus limensis* var. *limenanus*, *Phaseolus lunatus macrocarpus*, *Stizolobium deeringianum*, *Vigna catjang*, *Vigna sesquipedalis*, *Vigna sinensis*.

Geographical distribution: Florida, South Carolina, Virginia, District of

Columbia, Delaware, New Jersey, New York, Kentucky, Indiana, Wisconsin, Nebraska, Kansas, Japan.

Control: Selection of healthy seed from disease-free pods, cultivation of resistant varieties and crop rotation appear to offer the most promising means of control. Clayton (1928) found that pre and post blossom sprays with Bordeaux (4–6–50) or copper-lime dust (15–85) gave good control and gave increases in yields up to 43 per cent.

Literature

1892. Beach, S. A. Blight of lima beans. New York (Geneva) Agr. Exp. Sta. Bul. 48: 331, 1892. Bacterial spots with reddish purple borders and light red or straw-colored centers were observed on leaves and pods. The organism was isolated and successful inoculations were made.

1899. Sturgis, W. C. A bacterial blight of lima beans. Ann. Rpt. Connecticut Agr. Exp. Sta. for 1898, **22**: 262–263, 1899.

1921. Tisdale, W. B., and M. M. Williamson. Bacterial leaf spot of lima bean. Phytopath. **11**: 52, 1921. (Abstract.)

1923. Gardner, M. W., and J. B. Kendrick. Bacterial spot of cowpea. Science 57: 275, 1923. [2:485]

1923. Tisdale, W. B., and M. W. Williamson. Bacterial spot of lima bean. Journ. Agr. Res. **25**: 141–153, 1923.

1923. Bergey's Manual of Determinative Bacteriology, p. 188, 1923.

1924. Gardner, M. W. Indiana Plant Diseases, 1923. Proc. Indiana Acad. Sci. **33**: 172–173, 1924.

1925. Bergey's Manual of Determinative Bacteriology, pp. 208–209, 1925. (2nd ed.)

1925. Chupp, C. Manual of Vegetable-Garden Diseases, pp. 61–62, 1925.

1925. Gardner, M. W., and J. B. Kendrick. Bacterial spot of cowpea and lima bean. Journ. Agr. Res. **31**: 841–863, 1925. [5:401]

1926. Adams, J. F. Department of Plant Pathology. Ann. Rept. Delaware Agr. Exp. Sta. for year ending June, 1926, Bul. 147: 34, 1926. *Bacterium vignae* collected for the first time in Delaware on lima beans, in Aug., 1925.

1927. Bryan, M. K. Beef infusion versus beef extract media. Phytopath. **17**: 413–414, 1927. (Note.)

1928. Beach, W. S. The relation of *Bacterium vignae* to the tissues of lima bean. Pennsylvania State College Agric. Exp. Sta. Bul. 226: 3–14, 1928. [8:220]

1928. Beach, W. S. The characteristics and control of certain lima bean diseases. 40th Ann. Rpt. Pennsylvania Agr. Exp. Sta. Bul. 213: 15–16, (1928). *Bacterium vignae* in lima bean spreads through the intercellular spaces of the mesophyll of leaves and between the cortical cells in the pods.

1928. Clayton, E. E. Spraying experiments with bush lima beans. New York (Geneva) Agr. Exp. Sta. Bul. 558: 1–22, 1928. [8:417]

1928. Division of Botany. 46th Ann. Rept. New York (Geneva) Agr. Exp. Sta. for year ending June 30, 1927: 35, 1928. Spraying the lima bean plants before and after blossoming increased the yield while spraying only after blossoming did not. [7:363]

Bacterium viridilividum Brown, 1915

Motile by one to three polar flagella; 1.0–1.25 x 1.25–3.0μ; chains; no spores; Gram negative; not acid fast; no clouding in closed end of fermentation tubes; very young colonies round, smooth, with entire margins, translucent, cream-white, later having a denser margin, lighter colored than the center which may have yellowish bands or mottlings of the lighter margin in it; no gas; beef bouillon lime-green in ten days; milk cleared without coagulation becoming pale turtle-green; grows well in Uschinsky's and Fermi's solutions changing them to pale Veronese green and water green; slight growth in Cohn's; gelatin slowly liquefied; produces a fleeting dark blue-green color on potato cylinders; indol produced; nitrates not reduced; maximum temperature 34.5°–36°C.; minimum 1.5°C.; thermal death point 48°–49°C.

Synonymy:

Phytomonas viridilivida (Brown) Bergey et al., 1923.

Pseudomonas viridilivida (Brown) Stapp, 1928.

Symptoms: The diseased areas on the leaves show up first as numerous spots having a water-soaked appearance. As the spots increase in size and numbers, they fuse and form large lesions which eventually spread over the entire leaf. The leaf at first has a soft rotted appearance and later becomes shriveled and dry. The heart of the lettuce head may be sound while the outer leaves are soft rotted or shriveled and dry and the leaves between more or less affected. The Louisiana lettuce disease.

Hosts: *Lactuca sativa, Lycopersicum esculentum.*

Geographical distribution: Virginia, Louisiana, Michigan, New York.

Control: Levin (1917) found that spraying with formalin 1 pint in 30 gallons of water would check the disease. For control of stem end and center rot of tomato see *Bact. malvacearum.*

Literature:

1909. Fawcett, H. S. Bacterial rot. Florida Agr. Exp. Sta. Ann. Rept. 1908: 80–87, 1909.

1914. Burger, O. F. Bacterial rot. Florida Agr. Exp. Sta. Ann. Rept. 1913: 87–88, 1914.

1915. Brown, Nellie A. A bacterial disease of lettuce. Journ. Agric. Res. **4**: 475–478, 1915.

1917. Levin, E. Control of lettuce rot. Phytopath. **7**: 392–393, 1917.

1918. Brown, N. A. Some bacterial diseases of lettuce. Journ. Agr. Res. **13**: 367–388, 1918.

1923. Bergey's manual of Determinative Bacteriology, p. 187, 1923.

1925. Brookes, R. St. John, K. Nain and M. Rhodes. The investigation of phytopathogenic bacteria by serological and biochemical methods. Journ. Path. and Bakt. **28**: 203–209, 1925. See *Bacillus carotovorus.*

1926. Brown, N. A. A stem-end and center rot of tomato caused by various unrelated organisms. Journ. Agric. Res. **33**: 1009–1024, 1926.

1928. Stapp, C. Schizomycetes (Spaltpilze oder Bakterien). In Sorauer's Handbuch der Pflanzenkrankheiten 2 (fünfte auflage): 287, 1928.

Bacterium vitians Brown, 1918

Motile by one to several polar flagella; 0.42–0.83 x 0.62–1.24μ; short chains; capsules; no spores; aerobic; Gram negative; not acid fast; beef agar colonies light cream color to cream yellow, smooth, thin, round; growth on potato cylinders abundant, bright yellow; beef bouillon lightly clouded with an incomplete pellicle, sediment viscid; milk curdled and slowly peptonized; gelatin slowly liquefied; ammonia, hydrogen sulphide and indol (slight) produced; nitrates not reduced; feeble diastatic action; slight growth in Uschinsky's solution; very slight or no growth in Cohn's; no growth in Fermi's; optimum temperature 26–28°C.; maximum 35°C.; minimum below 0°C.; thermal death point 51–52°C.

Synonymy:

Phytomonas vitians (Brown) Bergey et al., 1923.

Pseudomonas vitians (Brown) Stapp, 1928.

Symptoms: This organism causes a wilting and rotting of leaves and stems of lettuce. In the early stages of the disease the infected plants are lighter green in color than the healthy ones. The stems, leaves and roots may all be affected, or the stem may be diseased and the leaves be perfectly healthy. General wilting may take place even when there are no spots on the leaves. The normal appearance of the disease on the leaves takes the form of definitely outlined, brown spots which may run together and form large areas of diseased tissue. In the early stages of the disease in the stem the tissues have a blue green color which later becomes brown. The diseased plants are easily broken off at the surface of the soil. South Carolina lettuce disease.

Host: *Lactuca sativa.*

Geographical distribution: Virginia, South Carolina.

Control: "The treatment recommended is the use of thoroughly decomposed green manure and well seasoned stable manure in which tissue-disintegrating bacteria have practically finished their work. The bacteria then present in the soil are not active and the plant, though weakened by sudden severe cold, may regain its stability and be able to resist their entrance. The use of satisfactory windbreaks is obvious." For control of stem end and center rot of tomatoes see *Bact. malvacearum.*

Literature:

1918. Brown, N. A. Some bacterial diseases of lettuce. Journ. Agr. Res. **13**: 367–388, 1918.

1923. Bergey's Manual of Determinative Bacteriology, p. 183, 1923.

1925. Brookes, R. St. John, K. Nain, and M. Rhodes. The investigation of phytopathogenic bacteria by serological and biochemical methods. Journ. Path. and Bakt. **28**: 203–209, 1925. See *Bacillus carotovorus.*

1926. Brown, N. A. A stem-end and center rot of tomato caused by various unrelated organisms. Journ. Agric. Res. **33**: 1009–1024, 1926.

1928. Stapp, C. Schizomycetes (Spaltpilze oder Bakterien). In Sorauer's Handbuch der Pflanzenkrankheiten **2** (fünfte auflage): 287–288, 1928.

Bacterium wieringae

Motile by one to five polar flagella; 0.5 x 2.0μ; no spores; Gram negative; beef agar colonies smooth, round, white to greyish, fluorescent; no gas from sugars; nitrates not reduced; milk dissolved in five days but not coagulated; optimum temperature 28°–30°C.; maximum 37°C.; minimum 0–4°C.; thermal death point 45°C.

Synonymy: *Phytomonas betae* Wieringa, 1927.

Symptoms: This organism causes a dark reddish brown to black discoloration of the parenchyma between the vascular bundles of fodder beets. Ring rot.

Host: *Beta vulgaris.*

Geographical distribution: Northern Holland.

Literature:

1927. Wieringa, K. T. Over een bacterieziekte in Bieten. Nederl. Tijdschr. Hygiëne, Microbiol. en Serol. (Leiden) 2: 149–152, 1927.

Bacterium (?) woodsii E. F. Smith, 1911

Motile; no spores; pearly white on potato and agar forming circular, small colonies; litmus milk blued without separation of casein; gelatin not liquefied; nitrates not reduced; maximum temperature about 35°C.; grows well in beef-bouillon, potato-broth and peptonized Uschinsky's solution.

Synonymy:

Pseudomonas woodsii (E. F. Smith) Stapp, 1928.

Phytomonas woodsii (E. F. Smith) Bergey et al., 1930.

See *Bacterium dianthi.*

Symptoms: Lesions are at first small and slightly brown with water-soaked borders. As they enlarge they collapse and dry leaving brown sunken areas surrounded by water-soaked margins. Badly diseased leaves soon wither.

Host: *Dianthus caryophyllus.*

Geographical distribution: Oklahoma, Pennsylvania, District of Columbia, North Carolina.

Control: The disease may be checked by burning diseased leaves and spraying the plants with a solution of formaldehyde (1–500). The plants should have as much air and light as possible and the foliage should be kept dry.

Literature:

1897. Woods, A. F. Bacteriosis of Carnations. Bot. Gaz. 24: 200–205, 1897; and Centralb. f. Bakt. 3: 722–727, 1897. Working with the leaf spot described by Arthur and Bolley, as due to *Bacterium dianthi*, he found by repeated experiments that aphids alone were capable of producing the disease and that neither fungi nor bacteria were present until the disease was well advanced and then not constantly and that infection experiments with such organisms resulted negatively in every case.

1903. Woods, A. F. Bacterial spot. A new disease of carnation. Science 18: 537–538, 1903.

1911. Smith, E. F Bacteria in Relation to Plant Diseases 2: 62 (footnote), 1911. (He states that the organism here in question is entirely distinct from *Bacterium dianthi.*)

1928. Stapp, C. Schizomycetes (Spaltpilze oder Bakterien). In Sorauer's Handbuch der Pflanzenkrankheiten 2 (5): 105–106, 1928.
1930. Bergey's Manual of Determinative Bacteriology, p. 242, 1930. (3rd ed.)

Bacterium xanthochlorum Schuster, 1912

Motile by one to three polar flagella; 0.75 x 1.5–3.0μ; no spores; Gram negative; facultative anaerobe; gelatin liquefied; agar colonies yellowish white to fluorescent; rapid growth in beef-bouillon with membranous pellicle and green fluorescence; milk coagulated and peptonized and green fluorescent; nitrates reduced; indol and hydrogen sulphide produced; no gas; acid from dextrose and galactose; diastatic action present; dense clouding in Uschinsky's solution and pure green fluorescence; optimum temperature about 35°C.; maximum over 44°C.; minimum under 2°C.; thermal death point about 51°C.

Synonymy:
Phytomonas xanthochlora (Schuster) Bergey et al., 1923.
Pseudomonas xanthochlora (Schuster) Stapp, 1928.

Symptoms: This is a wound parasite causing a slow, gray or yellow, wet-rot of the tuber, attacking the interior of the tuber through the vascular tissue. The organisms enter the stomata of *Vicia faba* leaves causing browning of vessels of leaflets and stems. Pitch black spots appear on the stems which break over in 24–48 hours after inoculation. The organism causes a white rot of lupins and *Physalis*. The organism appears to be at most a weak parasite attacking the plants under abnormal conditions of temperature and moisture.

Hosts: *Campanula rapunculus*, *Daucus carota*, *Lupinus nanus douglasi*, *Nicotiana tabacum*, *Physalis alkekengi*, *Solanum tuberosum*, *Vicia faba*.

Geographical distribution: Germany.

Control: Potatoes should be stored in a dry, cool place with the temperature below 8° and with a good circulation of air. Over fertilizing with quano, saltpeter or lime is to be avoided as they favor the development of the bacteria. Phosphate, superphosphate and ammonium sulfate are recommended. Diseased plants should be removed from the field. Resistant varieties should be planted and potatoes should not be followed by other susceptible plants such as soybean, lupin and tomato.

Literature:

1912. Schuster, J. Zur Kenntnis der Bakterienfäule der Kartoffel. Arb. aus der Kaiserl. Biolog. Anst. f. Land- und Forstw. **8**: 452–492, 1912. *Bact. xanthochlorum* n. sp. is a plant pathogenic form of the saprophyte *Bact. fluorescens*.
1912. Smith, E. F. A new method in bacterial research. Phytopath. **2**: 214–215, 1912.
1913. Brown, N. A., and C. O. Jamieson. A bacterium causing a disease of sugar-beet and nasturtium leaves. Journ. Agr. Res. **1**: 209–210, 1913.
1914. Smith, E. F. Schuster's German potato rot: Bacteria in relation to plant diseases **3**: 272–276, 1914.
1923. Bergey's Manual of Determinative Bacteriology, p. 180, 1923.

1925. Izrailsky, V. P., and E. V. Runov. (Resistance of potato varieties to bacterial diseases and virulence of bacteria.) Bolezn. Rast. **14**: 1–7, 1925. (In Russian with German summary.) Some of the 18 varieties were resistant to *Bact. xanthochlorum*.

1928. Stapp, C. Schizomycetes (Spaltpilze oder Bakterien). In Sorauer's Handbuch der Pflanzenkrankheiten 2 (fünfte auflage): 231–232, 1928.

Bacterium zingiberi (Uyeda) Nak. ?

Motile by one to three polar flagella; 0.5–1.1 x 0.75–1.8μ; no spores; Gram negative; white on agar; gelatin not liquefied; aerobic; milk coagulated and cleared; no gas; no indol; nitrates reduced; optimum temperature 28°C.; maximum 40°C.; minimum 5°C.

Synonymy: *Pseudomonas zingiberi* Uyeda, 1909. (Uyeda (1906) says this organism is non-motile.)

Symptoms: This organism causes a wilting of leaves followed by yellowing and browning and soft rot of the rhizomes.

Host: *Zingiber officinale.*

Geographical distribution: Japan.

Literature:

1906. Uyeda, Y. Eine Bakterienkrankheit von *Zingiber officinale.* Centralb. f. Bakt. **17**: 383–384, 1906.

1909. Uyeda, Y. (Studies on soft rot of ginger or "maybyo.") (In Japanese.) Rept. Imp. Agr. Exp. Sta. Japan No. 35: 105–140, 1909.

1911. Uyeda, Y. Die Roth-faule von Ginseng verursachtet durch *Bacillus araliavorus* und einige anderen Bakterien-arten. Miyabe-Festschrift, 75–115, 1911.

1914. Ideta, A. Hand-book of the plant diseases of Japan. (In Japanese.) 24–26, 1914.

1928. Hara, S. (A Thesaurus of Plant Diseases), p. 126, 1928. He gives *Bacterium zingiberi* (Uyeda and Ish.)Nak. Where and when the genus was changed has not been determined.

Clostridium persicae tuberculosis Cavara, 1897

He says nothing about inoculations. Colonies on gelatin milk white; gelatin liquefied; grows well at 20°–24°C.; single or in chains of 12–15μ; spores.

Synonymy: "By most writers of the last two decades the genus *Clostridium* has been submerged in *Bacillus*." (Buchanan 267, 1925.)

Bergey et al. (216, 1923) include this as a second genus in the family *Bacillaceae.*

Smith (1911) says "His account of the disease renders it uncertain whether he had to do with the pathological formations identical with those occurring on the peach in this country." "At any rate his organism"—"is a spore bearing liquefying organism quite distinct from the one causing crown gall on peach in this country."

Symptoms: This organism is said to cause tubercles 1–2 cm. in diameter on young branches.

Host: *Amygdalus persica.*

Geographical distribution: Pavia, Italy.

Literature:

1897. Cavara, F. Intorno alla eziologia di alcune malattie di piante coltivati. Tubercolosi del Pesco. Le Staz. Sperim. Agrar. Ital. **30**: 504–509, 1897.

1911. Smith, E. F., N. A. Brown, and C. O. Townsend. Crown-gall of plants: Its cause and remedy. U. S. Dept. Agric., B. P. I. Bul. 213: 16–17, 1911.

Micrococcus populi Delacroix, 1906

1.0 x 1.0–1.5μ; no capsules; no spores; no flagella; Gram negative; gelatin not liquefied, gelatin colonies opalescent and transparent.

Neither the technique of isolation nor the account of the infections claimed to have been obtained is very complete or satisfactory from the standpoint of the bacteriologist. See *Bacterium tumefaciens*.

Symptoms: Yellowish elongated spots appear on the grey bark, the cortical tissues become irregularly swollen and soon split lengthwise. When splitting occurs all the cortical tissues, including the cambium, are involved. At this stage the wood quickly takes on a brown color from the gum which accumulates and browns in the vessels. The region adjacent to the diseased cells becomes meristematic and gives rise to cushions of cells which isolate the diseased tissue. Young branches above the canker soon die. On branches a year or more old large cankers are formed.

Hosts: *Populus deltoides*, *Populus nigra*, *Populus regenerata*.

Geographical distribution: France, Italy, Belgium.

Control: Cut and burn infected branches.

Literature:

1906. Delacroix, G. Le chancre du peuplier. Bul. Mens. Off. Renseig. Agr. (Paris) 5: 1349–1352, 1906.

1906. Delacroix, G. Le chancre du peuplier. Ann. de L'Inst. Nat. Agron. 2 ser. **5**: 353–360, 1906.

1919. Regnier, R. Sur le chancre bactérien du peuplier (*Micrococcus populi*). Compt. Rend. Acad. Sci. (Paris) **169**: 85–88, 1919.

1920. Hartley, C., and G. G. Hahn. Notes on some diseases of aspen. Phytopath. **10**: 141–147, 1920. *Micrococcus populi* mentioned as the possible cause of killing of bark.

1923. Hiley, W. E. Fungus and bacterial diseases of poplars. Forestry Comm. Bul. (Gt. Britain) 5: 47, 1923. *Micrococcus populi* reported for the first time in Great Britain.

Phytomonas ricini Archibald, 1927

As plates were not poured, there is no assurance that he was working with pure cultures. 0.002 mm. x 0.0002 mm.; non-motile; no spores; aerobic; Gram negative; not acid fast; growth on agar viscid, dull gray, slightly raised, the medium turns brown to dark amber; blood serum liquefied; growth on potato white, viscid, glistening, on the fourth day assuming a brownish color; gelatin not liquefied; acid from salicin; no acid or gas from glucose, levulose, galactose, rhamnose, maltose, lactose, sucrose, raffinose, dextrin, inulin, starch, glycerol, erythrol, adonitol, dulcitol, mannitol; no indol; nitrates not reduced.

Synonymy: (According to Yoshi and Takimoto (1928) the disease described by Archibald is probably due to *Bacterium solanacearum.*)

Symptoms: This organism is said to cause water-soaked dark areas which finally become jet black on the under surfaces of leaves. The leaves finally yellow, shrivel and fall. Young lesions on the stem are water-soaked dark green, later turning black. When both stem and leaf are attacked the foliage wilts and falls.

Host: *Ricinus communis.*

Geographical distribution: Trinidad Island.

Literature:

1927. Archibald, R. G. The castor oil plant (*Ricinus communis*). Black rot in the Gezira. Trop. Agric. (Trinidad) 4: 124–125, 1927.

Proteus nadsonii Lobik, 1915

Motile by five to seven peritrichiate flagella; 0.7 x 1.0–2.8μ; chains; no spores; polymorphic; Gram variable; growth on agar gray with metallic luster, later brown, round to lacinate; gelatin liquefied; bouillon clouded with pellicle; milk curdled but not peptonized; growth on potato white, then gray and finally yellowish brown; gas formed; hydrogen sulphide and ammonia produced; no indol.

Symptoms: This organism causes a dry to wet rot of potato tubers. The infected tissue turns brown and there is a dark violet line which separates healthy from infected tissue. The skin becomes wrinkled and a brown liquid flows from the cracks.

Hosts: *Solanum tuberosum, Lycopersicum esculentum.*

Geographical distribution: Russia.

Control: Potatoes should be stored only under the best conditions. All diseased tubers should be removed.

Literature:

1915. Lobik, A. I. (On a new bacteriosis of potato tubers caused by *Proteus nadsonii* n. sp.) Journal "Diseases of Plants," Petrograd 9: 67–77, 1915. (In Russian.) For a discussion of this genus see Buchanan, R. E. General systematic bacteriology 1: 432–433, 1925.

Pseudomonas solaniolens Paine, 1923

Motile by a single polar flagellum; no spores; iridescent on gelatin; gelatin not liquefied; pale buff color on agar and potato; no gas; acid from glucose; no acid from lactose, sucrose, mannit, glycerin; nitrates not reduced; feeble diastatic action; milk curdled but not cleared; litmus turned pink; earthy potato smell. There is also a non-smelling strain which is non-motile.

(1918) All Paine says about isolations is "by inoculations of diseased tissue into sterile potato broth an organism has with difficulty been obtained." Speaking of his inoculations, Paine (1923) says "These experiments, it must be stated, have not yet given the same general infection as is met with in the naturally diseased tuber." (1926) Quanjer does not accept *Ps. solaniolens* as the cause of internal brown spot. (1928) Stapp discusses this disease and concludes by saying that further proof of Paine's experiments is necessary before this organism can be accepted as the cause of this disease.

Synonymy:

Phytomonas solaniolens (Paine) Bergey et al., 1930.

See *Bacterium rubefaciens*, *Bacterium suberfaciens*.

Symptoms: This organism is said to cause brown patches and a scabby appearance on the outer surface of potato tubers and internally discolored brownish red or rusty patches. In type A, known as sprain the storage tissue is spotted with reddish brown corky islands up to 0.5 cm. in diameter which may break at the center and form cavities. Type B, known as net necrosis, has fine strands of dark brown or chocolate colored corky tissue running through the tissue or radiating from pith to vascular ring or following the internal phloem.

Host: *Solanum tuberosum*.

Geographical distribution: Europe, America.

Literature:

1908. Swellengrebel, N. H. Sur la nature et les causes de la maladie des taches en couronne chez la pomme de terre. Arch. Néerland. des Sci. Exact. et Nat. **13**: 151–198, 1908.

1910. Horne, A. S. The symptoms of internal disease and sprain (streak disease) in potato. Journ. Agr. Sci. **3**: 322–332, 1910.

1917. Jones, L. R., and E. Bailey. Frost necrosis of potato tubers. Phytopath. **7**: 71–72, 1917. "Moderate exposure to freezing temperature may produce either 'ring' or 'net' necrosis."

1918. Paine, S. G. "Internal rust spot" disease of the potato tuber. (Preliminary communication.) Ann. Appl. Biol. **5**: 77–79, 1918.

1919. Jones, L. R., M. Miller and E. Bailey. Frost necrosis of potato tubers. Wisconsin Agr. Exp. Sta., Res. Bul. **46**: 1–46, 1919.

1923. Paine, S. G. "Internal rust spot" disease of the potato tuber. (Synonyms: sprain, net necrosis, eisenfleckigheit, kringerigheid, buntwerden, und maladie des taches en couronne.) Rept. Internat. Conf. Phytopath. and Econ. Ent. Holland 1923: 74–78, 1923.

1925. Appel, O. Die Eisen-oder Buntfleckigkeit. Taschenatlas der Kartoffelkrankheiten I Teil, 1925. He states that this is not a parasitic disease.

1926. Quanjer, H. M. Waarnemingen over "Kringerigheid" of "vuur" en over "netnecrose" van aardappelen. Tijdschr. over Plantenziekten **32**: 97–128, 1926. (English summary.) Attempts to isolate an organism have not met with success. Paine (1923 attributes net necrosis and sprain both to *Ps. solaniolens* n. sp. but his infection experiments are not convincing.

1926. Millard, W. A. Internal rust spot of potatoes. Nature **118**: 804, 1926. In a study of the etiology of sprain or internal rust spot of potato he isolated 2 rod-shaped bacteria with which he reproduced the disease. They bear no resemblance to *B.* (*Pseud.*) *solaniolens* isolated by Paine.

1926. Schwarz, M. B. De roestvlekkenziekte van aardappelknollen in nederlandsch oost-indie. Tijdschr. over Plantenziekten **32**: 321–330, 1926. (English summary.) Rusty spot of East Indies seems to be different from net necrosis and sprain.

1928. Stapp, C. Schizomycetes (Spaltpilze oder Bakterien). In Sorauer's Handbuch der Pflanzenkrankheiten 2 (fünfte auflage): 247–248, 1928.

1930. Bergey's Manual of Determinative Bacteriology, p. 243, 1930. (3rd. ed.)

NON-PATHOGENIC ORGANISMS

NON-PATHOGENIC ORGANISMS

Aplanobacter dissimulans Paine and Lacey, 1922

Found frequently associated with stripe disease of tomato.

Literature:

1919. Paine, S. G., and W. F. Bewley. Studies in Bacteriosis IV. "Stripe disease of tomato." Ann. Appl. Biol. **6**: 200–202, 1919. A non-motile, Gram positive, non-parasitic organism similar to *Aplanobacter michiganense* was isolated from striped tomato and the author suggests that *Aplanobacter michiganense* may also be a saprophyte.

1922. Paine, S. G., and M. S. Lacey. Studies in bacteriosis VII. Comparison of the "stripe disease" with the "Grand Rapids disease" of tomato. Ann. Appl. Biol. **9**: 210–212, 1922. A comparison of organisms and cross inoculations show that "The stripe disease and the Grand Rapids disease of tomato are distinct diseases caused by two bacterial parasites, *Bacillus lathyri* and *Aplanobacter michiganense.*" The earlier suggestion that the Grand Rapids disease might be due to *Bacillus lathyri* is withdrawn.

Bacillus aeruginosus Delacroix, 1903

Said to cause cankers on tobacco.

Synonymy: (Griffon (1909) considers *Bacillus aeruginosus* Delacroix as either *Bacillus fluorescens liquefaciens* or *Bacillus fluorescens putridus* Flügge). (Delacroix et Maublanc (1926) state that *Bacillus aeruginosus* Delacroix is very closely related to *Bacillus fluorescens putridus* Flügge of which it is probably only a form.)

Smith (1914) says "*Bacillus aeruginosus* Schröter is earlier (1886) and consequently Delacroix's name should be rejected and in the present stage of our knowledge of the disease it is scarcely worth while to suggest a substitute."

Literature:

1872. Schroeter, J. Ueber einige durch Bacterien gebildete Pigmente. Cohn's Beitrage zur Biologie der Pflanzen. **1**: 126, 1872.

1886. Schroeter, J. Schizomycetes. Cohn's Kryptogeme-Flora von Schlesien. **3**: Part 1, 157, 1886.

1903. Delacroix, G. Sur une maladie bacterienne du tabac, le "chancre" ou "anthracnose." Compt. Rend. Acad. Sci. (Paris) **137**: 454–456, 1903.

1906. Delacroix, G. Recherches sur quelques maladies du tabac en France. Ann. de L'Inst. Nat. Agron. **5**: 141–203, 1906.

1909. Griffon, Ed. Sur le role des bacilles fluorescents de Flügge en pathologie vegetale. Compt. Rend. **149**: 50–53, 1909.

1914. Smith, E. F. Bacteria in Relation to Plant Diseases **3**: 266–267, 1914.

1926. Delacroix, G., et A. Maublanc. Maladies des Plantes Cultivees **2**: 412–413, 1926.

Bacillus amyloaërobius Crimi, 1922

Isolated from a potato decomposing under water.

Literature:

1922. Crimi, P. Coltivazione ed isolamento di una specie batterica aërobica comportantesi da amilo-batterio e da fermento butirrico. R. Istit. Incorag. Napoli, Staz. Sper. Malattie Infettive Bestiame Portici, 43 pp., 1922. Centr. Bakt. 2, **61**: p. 63, 1924. This is a review or abstract of Crimi's paper.

Bacillus amylobacter van Tieghem, 1877

Said to cause a rot of vegetable tissues, potato, tobacco, turnip, Juniper.

Synonymy:

Clostridium butyricum Prazmowski.

Bacterium navicula Reinke und Berthold (according to Migula). Bergey considers *Bacillus amylobacter* a synonym of *Clostridium butyricum* Prazmowski.

See *Bacillus phytophthorus*.

Literature:

1877. van Tieghem Ph. Sur le *Bacillus amylobacter* et son role dans la putrefaction des tissues vegetaux. Bul. Soc. Bot. de France **24**: 128–135, 1877.

1879. Reinke, J., und G. Berthold. Die Zersetzung der Kartoffel durch Pilze. Untersuch. aus dem Bot. Labor. der Univ. Gottingen **1**: 7–100, 1879.

1880. Prazmowski, A. Untersuchungen über die Entwickelungsgeschichte und Fermentwirkung einiger Bacterien—Arten. Leipzig, p. 24, 1880.

1884. van Tieghem, Ph. Developpement de l'amylobacter dans les plantes a l'etat de vie normale. Bul. Soc. Bot. de France. **31**: 283–287, 1884.

1893. Comes, O. Mortalita delle piantine di tobacco nei semenzai cogionata da marciume della radice **6**: 1–8, 1893. (Rev. in Bot. Centralb. **56**: 253–254, 1893.)

1898. Cavara, F. Tumori di natura microbica nel *Juniperus phoenicea*. Bull. della Soc. Bot. Italiana, pp. 241–250, 1898.

1900. Migula, W. System der Bakterien. **2**: 536–537, 1900.

1925. Bergey's Manual of Determinative Bacteriology, 326, 1925.

Bacillus atherstonei Smith, R. G., 1904

Isolated from the tissues of *Strychnos atherstonei*.

Literature:

1904. Smith, R. G. A variable galacton *Bacterium* (*Bacillus atherstonei*). Proc. Linn. Soc. N. S. Wales, Part 3, June 29, 1904.

Bacillus augescens Senus, 1890

Isolated from rotting leaves.

Literature:

1890. Senus, A. H. C. van. Bijdrage tot de Kennis der Cellulosegisting. T. M. H. Leonards, Leiden, pp. 1–186, 1890. (Thesis for doc-

torate at Rijks-Hoogeschool te Leiden.) (Original not seen.) Abstract in Koch, A. Jahresbericht Gährungs-organismen 1 (1890): 136–139, 1891.

Bacillus baccarinii Macchiati, 1897

(*Clostridium baccarinii* (Macchiati) Bergey et al., 1923.)

0.65–0.8 x 2.0–3.3μ; chains; spores; flagella peritrichiate; gelatin liquefied; milk coagulated and peptonized; yellow on agar, potato, gelatin; aerobic; diastase formed.

He made no inoculations.

For discussion, symptoms and literature see *Bacterium gummis*.

Bacillus betae Busse, 1897

Isolated from beets showing blackening of fibrovascular bundles and formation of gummy liquid. See *Bacillus bussei*.

Synonymy: *Bacillus lacerans* Migula. He made no inoculations with strains α and γ.

Literature:

1897. Busse, W. Bacteriologische Studien über die "Gummosis" der Zuckerruben. Zeitsch. f. Pflanzenkrank. 7: Heft 2, 65–76, Heft 3, 149–155, 1897.

1897. Busse, W. Bakteriologische Studien über die "Gummosis" der Zuckerrüben. Centralblatt fur Bakter. 3: 680–682, 1897. Same as Zeitschr. fur Pflanzenkr. 7: 65–149, 1897. *Bacillus betae* n. sp. (*Bacillus* α and γ).

1900. Migula, W. System der Bakterien 2: 779, 1900.

Bacillus betae Migula, 1900

Isolated from shriveled beets showing exuding of gum and browning and soft rot of all but vascular tissue.

Synonymy: Migula named the species from Kramer's work but this name has already been used by Busse in 1897. Kramer's organism remains unnamed. He reproduced the disease on slices of beets but attempts to reproduce the disease on sound beets with pure cultures were not successful.

Literature:

1891. Kramer, E. Die Bacteriosis der Runkelrube (*Beta vulgaris* L.) eine neue Krankheit derselben. Oesterr. Landwirtsch. Centralb. 1: Heft 2, 30–36, Heft 3, 40–41, 1891.

1896. Smith, E. F. The bacterial diseases of plants: a critical review of the present state of our knowledge. American Naturalist 30: 716–723, 1896.

1898. Smith, E. F. Occurrence of Kramer's bacterial disease of sugar beets in the United States. Bot. Gaz. 25: 108–109, 1898.

1900. Migula, W. System der Bakterien 2: 779, 1900.

Bacillus caulivorus Prillieux et Delacroix, 1890

Said to cause cankers on stems of potato, begonia, tomato, lupin, gloxinia, tobacco, bean, cyclamen, and pelargonium in France and Italy.

Synonymy: A synonym of *Bacillus fluorescens liquefaciens* Flügge according to Laurent (1899), Griffon (1909), Delacroix (1927).

See *Bacterium fluorescens* (Flügge) Lehmann-Neumann.

No description of the organism or of methods of isolation are given.

Literature:

1890. Prillieux, E., et G. Delacroix. La gangrene de la tige de la pomme de terre, maladie bacillaire. Compt. Rend. Acad. Sci. (Paris) **111**: 208–210, 1890.

1899. Laurent, E. Recherches experimentale sur les maladies des plantes. Inst. Pasteur Ann. **13**: 1–48, 1899.

1909. Griffon, E. Sur le role des bacilles fluorescents de Flügge en pathologie vegetale. Compt. Rend. Acad. Sci. (Paris) **149**: 50–53, 1909.

1927. Delacroix, G. Maladies des Plantes Cultivees **1**: 354, 1927.

Bacillus cloacae Jordan, 1890

Isolated from sewage and said to cause dwarfing, yellowing and darkening of young corn plants, decay of roots, and formation of irregular brown blotches especially on the inner surfaces of leaf sheaths.

Synonymy:

Bacterium zeae (Burrill, 1889) Comes, 1891.

Bacillus secales (Burrill) Ludwig, 1892.

Bacillus zeae (Burrill) Russell, 1892.

Smith (1893), Moore (1896) and Smith (1914) identify Burrill's corn organism with *Bacillus cloacae* Jordan.

Literature:

1889. Billings, F. S. The "Corn-stalk" disease in cattle. Nebraska Agric. Exp. Sta. Bul. 8: 165–210, 1889. Contains a letter of Burrill's of May 1, 1889, describing the corn disease of Illinois.

1889. Burrill, T. J. A bacterial disease of India corn. Proc. 10th Ann. Meeting Soc. Prom. Agric. Sci. **7**: 19–27, 1889. Also in Univ. Illinois Agr. Exp. Sta. Bul. 6: 165–175, 1889.

1889. Proc. American Assoc. Adv. Sci. **38**: 280, 1889. Infections were secured but the organism was not named. Probably several diseases were confused.

1890. Jordan, E. O. On certain species of bacteria observed in sewage. Experimental Investigations by the State Board of Health of Massachusetts 1888, 1890. Report on Water Supply and Sewerage 2: 821–844, 1890.

1891. Comes, O. Crittogamia Agraria **1**: 500, 1891.

1892. Billings, F. S. Original investigations of cattle diseases in Nebraska, Animal Disease Ser. IV also known as Bul. 22–23, Article I, The corn fodder disease in cattle, etc. Nebraska Agr. Exp. Station, pp. 50–53, 1892. Letters from Burrill to Billings.

1892. Duncanson, H. B. A bacterial disease of corn. Publications of Nebraska Acad. Sci. **2**: 21–23, 1892. Abstract of paper read at Lincoln, Dec. 31, 1891.

1892. Ludwig, F. Lehrbuch der neideren Kryptogamen, p. 95, 1892. *Bacillus secales* (Burrill.) The name *B. secales* appears to have been given under the impression that the word "corn" has the same meaning in the United States as in England.

1893. Smith, Theobald. The fermentation tube with special reference to anaerobiosis and gas production among bacteria. The Wilder Quarter-Century Book, pp. 214–217, 1893.
1894. Moore, V. A. An inquiry into the alleged relation existing between the Burrill disease of corn and the so-called corn-stalk disease of cattle. Agric. Sci. 8: 368–385, 1894. Moore compared his isolation from corn-stalk disease with a pure culture received from Burrill and found them to be the same as *Bacillus cloacae.*
1896. Moore, V. A. Cornstalk disease and rabies in cattle. U. S. Dept. of Agric., B. A. I. Bul. 10: 45–47, 1896.
1897. Chester, F. D. A preliminary arrangement of the species of the genus *Bacterium.* Ann. Rept. Delaware Col. Agr. Exp. Sta. 9: 53–145, 1897.
1897. Steward, F. C. A bacterial disease of sweet corn. New York Agr. Exp. Sta. (Geneva) Bul. 130: 436, 1897.
1900. Migula, W. System der Bakterien 2: 776–777, 1900.
1914. Smith, E. F. Bacteria in Relation to Plant Diseases 3: 147, 1914.

Bacillus elegans Hegyi, 1899

No description of the organism is given.

Said to cause brown leaf spots on lupins and a yellowing and drying of the whole plant.

Literature:

1899. Hegyi, D. A bacterial disease of the lupin. (In Hungarian.) Kisérletügyi Közlemenyek 2: 232–235, 1899.
1927. Pape, H. Krankheiten und Schädlinge, der Lupine. Illus. Landw. Zeit. 47: 316–318, 1927. *B. elegans* reported as cause of a leaf spot.

Bacillus erraticus Senus, 1890

Isolated from rotting leaves.

Literature:

1890. Senus, A. H. C. van. Bijdrage tot de Kennis der Cellulosegisting. T. M. H. Leonards, Leiden, pp. 1–186, 1890. (Thesis for doctorate at Rijks-Hoogeschool te Leiden.) (Original not seen.) Abstract in Koch, A. Jahresbericht Gährungs-organismen 1 (1890): 136–139, 1891.

Bacillus flavus Senus, 1890

Isolated from rotting leaves.

Literature:

1890. Senus, A. H. C. van. Bijdrage tot de Kennis der Cellulosegisting. T. M. H. Leonards, Leiden, pp. 1–186, 1890. (Thesis for doctorate at Rijks-Hoogeschool te Leiden.) (Original not seen.) Abstract in Koch, A. Jahresbericht Gährungs-organismen 1 (1890): 136–139, 1891.

Bacillus fluorescens putridus Flügge, 1896

Isolated from water and decaying substances; said to cause rotting of cabbage and potato tubers at high temperatures.

Flügge, 1886 and 1896 and Migula, 1900 say nothing about flagella.

Synonymy:

Bacillus fluorescens putidus Flügge, 1886.

Pseudomonas putrida (Flügge) Migula, 1900.

See *Bacillus brassicaevorus* Delacroix.

See *Bacillus aeruginosus* Delacroix.

Literature:

1886. Flügge, C. Die Mikroorganismen, p. 288, 1886.

1896. Flügge, C. Die Mikroorganismen, p. 292, 1896.

1899. Laurent, E. Recherches experimentales sur les maladies des plantes. Annales de L'Inst. Pasteur **13**: 1–48, 1899.

1900. Migula, W. System der Bakterien **2**: 912, 1900.

1909. Griffon, Ed. Sur le role des bacilles fluorescents de Flügge en pathologie vegetale. Compt. Rend. Acad. Sci. (Paris) **149**: 50–53, 1909.

Bacillus gallicus Freire, 1899

Isolated from stamens of rose.

Literature:

1899. Freire, D. Les microbes des fleurs. Compt. Rend. Acad. Sci. (Paris) **128**: 1047–1049, 1899.

Bacillus glagae Janse, 1891

Said to cause sereh—a shortening of internodes, abnormal stooling, a red staining of vascular bundles, and formation of yellow gum or slime in the bundles of sugar cane.

Synonymy: See *Bacillus sacchari* Janse.

Literature:

1891. Janse, J. M. Het voorkomen van bacterien in suikerriet. Meded. uit's Lands Plantentium **9**: 1–54, 1891.

1897. Migula, W. System der Bakterien **1**: 312, 1897.

Bacillus indurans R. G. Smith, 1905

Isolated from the tissues of *Schinus molle* which was exuding gum.

Literature:

1905. Smith, R. G. A gelatin-hardening bacterium (*Bacillus indurans* n. sp.). Proc. Linn. Soc. N. S. Wales, Part 2, Aug. 30, 1905.

Bacillus iriodes Senus, 1890

Isolated from rotting leaves.

Literature:

1890. Senus, A. H. C. van. Bijdrage tot de Kennis der Cellulosegisting. T. M. H. Leonards, Leiden, pp. 1–186, 1890. (Thesis for doctorate at Rijks-Hoogeschool te Leiden.) (Original not seen.) Abstract in Koch, A. Jahresbericht Gährungs-organismen **1** (1890): 136–139, 1891.

Bacillus irritans Aderhold and Ruhland, 1907

Associated with *Bacillus spongiosus* on cherry.
Literature:

1907. Aderhold, R., und W. Ruhland. Bakterienbrand der Kirschbaume. Kaiser. Biol. Anstalt. Land und Forstw. **5**: 293–340, 1907.

Bacillus levaniformans R. G. Smith, 1901

Isolated from expressed sugar cane juice.
Literature:

1901. Smith, R. G. The gum fermentation of sugar cane juice. Proc. Linn. Soc. N. S. Wales **26**: 589–625, 1901.

Bacillus lini R. G. Smith, 1905

Isolated from plant tissues chiefly stems of flax.
Literature:

1905. Smith, R. G. The probable bacterial origin of the gum of the linseed mucilage. (*Bacillus lini* 1–2 n. sp.) Proc. Linn. Soc. N. S. Wales, Part 1, April 26, 1905.

Bacillus lycopersici Hegyi, 1899

Said to cause blossom end rot of tomato.
See *Bacterium briosii*.
Literature:

1899. Hegyi, G. A paradicsom bacteriosis-betegségéröl. (A bacterial disease of tomato.) Kiserlet. Közlens. **2**: 230–231, 1899. (In Hungarian.) He claims to have reproduced the disease by pure culture inoculation.

Bacillus macrozamiae R. G. Smith, 1904

Isolated from the gelatinous gum exuding from the fruit of macrozamia.
Literature:

1904. Smith, R. G. The bacterial origin of macrozamia gum (*Bacillus macrozamiae* n. sp.) Proc. Linn. Soc. N. S. Wales, Part 4, Nov. 30, 1904.

Bacillus megaterium de Bary, 1887

Said to cause a spot disease of potato. Rods 2.5μ thick and 4 to 6 times as long; motile with 4 to 8 flagella; spores; white on agar and gelatin; gelatin liquefied; on agar slant a white growth with slight tinge of reddish yellow.
Literature:

1887. DeBary, A. Comparative morphology and biology of the Fungi, Mycetozoa and Bacteria, pp. 463–466, 1887. Found on cooked cabbage leaves.

1908. Swellengrebel, N. H. Sur la nature et les causes de la maladie des taches en couronne chez la pomme de terre. Arch. Neerland. Sci. Exact. et Nat. **13**: 151–195, 1908.

Bacillus mori carneus Cavara, 1897

Found on plates of *Bacterium mori* Boyer and Lambert.

Literature:

1897. Cavara, F. Intorno alla eziologia di alcune malattie di piante coltivate. Staz. Sperim. Agr. Ital. Modena, **30**: 499–504, 1897.

Bacillus morulans Boncquet, 1917

Isolated from beet leaves affected with curly top and also from seed and soil, and from the surface of normal sugar beet leaves.

Synonymy:

Bacillus californiensis Schneider, 1906.

See *Bacterium dianthi*.

Literature:

1906. Schneider, A. The California beet blight. Spreckles Sugar Co., Exp. Sta. Rept. **23**: 1906. (Unpublished.)

1909. Ball, E. D. The leaf hoppers of the sugar beet and their relation to the "curly leaf" conditions. U. S. Dept. Agr., Bur. Ent. Bul. 66: p. 4, 1909.

1915. Smith, R. E., and P. A. Boncquet. Connection of a bacterial organism with curly leaf of the sugar beet. Phytopath. **5**: 335–341, 1915. All inoculations with *Bacillus dianthi* failed.

1915. Smith, R. E., and P. A. Boncquet. New light on curly top of the sugar beet. Phytopath. **5**: 103–107, 1915. The organism isolated agrees with *Bacillus dianthi* Bolley. Inoculations gave negative results.

1917. Boncquet, P. A. *Bacillus morulans* n. sp. A bacterial organism found associated with curly top of sugar beet. Phytopathology **7**: 269–289, 1917.

1924. Severin, H. H. P. Curly leaf transmission experiments. Phytopath. **14**: 80–93, 1924. Experiments to determine whether the beet leaf hopper increases the virulence of *Bacillus morulans* isolated from curly leaf beets gave negative results.

Bacillus mycoides Flügge, 1886

Associated with bacteria causing wilt of tobacco, said to cause rotting of potato tubers and beet seedlings at high temperatures, and with difficulty a center rot of tomato.

Literature:

1886. Flügge, C. Die Mikroorganismen **2**: 324–325, 1886.

1899. Linhart, G. Krankheiten des Rubensamens. Centralb. f. Bakt. 2 abt. **5**: 221–222, 1899.

1899. Stoklasa, J. Welchen Einfluss haben die Samenknauel auf die Entwicklung der Zuckerrube? Centralb. f. Bakt. 2 abt. **5**: 720–726, 1899, and Zeitschr. f. Zuckerindustr. in Böhmen. **23**: 646–655, 1899.

1902. Lepoutre, M. L. Recherches sur la transformation experimentale de bacteries banales en races parasites des plantes. Annales de L'Institut Pasteur **16**: 304–312, 1902.

1912. Honing, J. A. Over rottingsbacterien uit slijmzieke tabak en djatti en enkele andere van slijmziekte verdachte planten. Mededeel. van Het Deli Proefstation te Medan. Jaargang 7: 6e Aflev., 223–253, 1912.
1915. Serbinoff, I. L. Bacterial diseases of potato. Journal "Diseases of Plants" 9: 13–38, 1915. (In Russian.)
1926. Brown, N. A. A stem-end and center rot of tomato caused by various unrelated organisms. Journ. Agr. Res. 33: 1009–1024, 1926.

Bacillus nelumbii Uyeda, 1907

Said to cause a purple brown discoloration and shrinking and rotting of the rhizome and a yellowing, rolling inward of margins and finally a wilting of the leaves of lotus.

No description of the organism is given.

Literature:

1907. Hori, S. (The field experiment on the control of the rhizome-rot of lotus (*Nelumbium speciosum* Wild.).) Rept. Imp. Agr. Exp. Sta., Japan. Nr. 34: 95–99, 1907.
1907. Hori, S. (On the rhizome-rot of lotus.) Dainihon-Nokaiho Jour. Agr. Soc. Japan Nr. 319: 9–14, 1908.
1914. Ideta, A. (Hand book of plant diseases of Japan), p. 82, 1914.

Bacillus omelianskii Serbinoff, 1915

Said to cause a soft black rot of stems of sorghum.

Serbinoff says his organism is non-motile.

There is no evidence that he was working with pure cultures and no inoculations are described.

Literature:

1915. Serbinoff, I. L. *Bacillus omelianskii* nov. sp. nouveau microbe butyrique, comme instigateur "gommose bacillaire" du sorgho. Journal Bolyzne Rastenii No. 4–5; 95–113, 1915. (Original in Russian—French resumé.)

Bacillus oryzae Hori and Bokura, (1912) ?

Associated with *Bacterium oryzae* (Uyeda and Ishiyama) Nak. in the white-spot disease of rice. Voglino used this combination in 1905.

0.8–1.2 x 1.8–3.0μ; no spores; motile by peritrichiate flagella; Gram negative; gelatin not liquefied; agar colonies yellow white, circular; facultative anaerobe; indol and hydrogen sulphide produced; milk cleared; optimum temperature 30°C.; maximum 40°C.; thermal death point 54°C.

Literature:

(1912)? Bokura, U. "Teikoku Nogaku Kwaiho." (Journal Imperial Agric. Society of Japan) 2: No. 9, 10, 12, (1912)? He named the organism here (according to Ideta) but did not prove its pathogenicity.
1925. (White withering disease of rice leaves.) In Ideta's (Supplement to Handbook of the Plant Diseases of Japan) 1: 68–73, 1925. The description of the organism is taken from this publication as it is thought to be *Bacillus oryzae* Hori and Bokura.

Bacillus oryzae Kohlbrugge, 1911

Said to cause a souring of rice.
This name was used earlier by Voglino.
Literature:
1911. Kohlbrugge, J. H. Die Garungskrankheiten (beri-beri, scorbut, barlowskrankheit, cholera nostras u. a.). Centralb. f. Bakt. **60**: 223–240, 1911.

Bacillus oryzae Voglino, 1905

Said to cause drying of leaf tips, reddening of leaf blades, swelling and softening of nodes and browning and drying of roots of rice in Italy.
No description of the organism is given.
Literature:
1897. Voglino, P. Ricerche intorno alla malattia del riso conosciuta col nome di brusone. Annali della R. Accademia d'Agricoltura di Torino. **40**: 143–146, 1897. Published in 1898.
1905. Voglino, P. Patologia Vegetale, pp. 43–44, 1905.

Bacillus petroselini Potebnia, 1915

Said to cause small angular yellowish spots with brown borders on the leaves of parsley.
No inoculation tests are recorded.
0.5 x 0.8 in resting state in host tissue, 1.0–1.5 x 5.0–9.0μ in motile state; forms large zoogloeae; colonies on beef agar and gelatin white at first turning okra-yellow; gelatin not liquefied; not sensitive to drying.
Literature:
1915. Potebnia, A. A. Fungus parasites of the higher plants in Kharkov and adjacent provinces. Kharkov Prov. Agr. Exp. Sta. No. **1**: 34–35, 1915. (In Russian.)

Bacillus pseudarabinus R. G. Smith, 1904

Said to cause reddening and gumming of vascular tissue of sugar cane.
Literature:
1904. Smith, R. G. The red string of the sugar cane. *Bacillus pseudarabinus* n. sp. Proc. Linn. Soc. N. S. Wales, Part 3, June 29, 1904.
1914. Smith, E. F. Bacteria in relation to plant diseases **3**: 49–52, 1914. "In 1904, R. Greig Smith investigated the red vascular bundles of gummed cane and reached the conclusion that the stain must be due to the symbiotic action of an undetermined pycnidia-bearing fungus and a white slime producing bacillus, named by him *B. pseudarabinus*. This is peritrichiate and non-sporiferous, liquefies gelatin slowly, and does not stain by Gram." "Greig Smith did not reproduce this disease by inoculations into living cane."

Bacillus putrefaciens Ray, 1901

Said to cause rotting and blackening of seedlings of bean, lupin, wheat, oat, sunflower, and radish.

Whitish to rose on solid media, produces diastase in bouillon.

Literature:

1901. Ray, J. Les maladies cryptogamiques des végétaux. Revue Generale de Botanique 13: 145–151, 1901.

Bacillus putrefaciens liquefaciens Delacroix, 1906

Said to cause rotting of tobacco seedlings and to attack *Begonia rex*.

Delacroix attributes this name to Flügge but Flügge (1886) or (1896) does not name this organism. Delacroix may consider this organism the same as *Bacillus fluorescens liquefaciens* Flügge. This organism is not described.

Literature:

1886. Flügge, C. Die Mikroorganismen. 1886.
1896. Flügge, C. Die Mikroorganismen. 1896.
1906. Delacroix, G. Recherches sur quelques maladies du tabac en France. Ann. de L'Inst. Nat. Agron. 5: 156–157, 1906.
1915. Foex, E. Rapport phytopathologique pour l'anne 1913. Annales du Service des Epiphyties 2: 63, 1915.

Bacillus pyocyaneus Gessard, 1882

Isolated from pistils and stamen of peach. A synonym of *Ps. aeruginosa* (Schröter) Mig.

Literature:

1882. Gessard, C. De la pyocyanine et de son microbe. Thèse de Paris, No. 248, p. 45, 1882.
1899. Freire, D. Les microbes des fleurs. Compt. Rend. Acad. Sci. (Paris) 128: 1047–1049, 1899.
1900. Migula, W. System der Bakterien 2: 884, 1900.

Bacillus rosarum Scalia, 1903

Said to cause tumors at the bases of old trunks and branches of roses.

The organism is imperfectly described, 1–1.5 x 0.2–0.3μ, and there is no record of inoculation experiments.

The organism is named on the strength of microscopic examination.

Literature:

1903. Scalia, G. Bacteriosi delle rose. Nota preliminare. L'Agric. Calabro-Siculo 28: 75–78, 1903.

Bacillus roseus Trevisan, 1889

Isolated from imperfectly sterilized slices of potatoes.

Synonymy:

Bacillus mesentericus ruber (Globig) Flügge, 1896.

Bacillus globigii Migula, 1900.

Bacillus vitalis Chester, 1901. (Globig (1888) gave a brief description of an organism isolated from potato but did not name it. Trevisan, Flügge, Chester and Migula named the organism from Globig's description.)

Literature:
1888. Globig. Ueber einen Kartoffel-bacillus mit ungewohnlich widerstandsfahigen Sporen. Zeitschr. f. Hygiene u. Infek. **3**: 322–332, 1888.
1889. Saccardo, P. A. Sylloge Fungorum **8**: 985, 1889.
1889. Trevisan, V. I generi e le specie delle batteriacee. Milano, 1889.
1891. Tartaroff. Die Dorpater Wasserbakterien. Inaug. Dissert. Dorpat, p. 21, 1891. (This reference from Migula.)
1896. Flügge, C. Die Microorganismen **2**: 199, 1896.
1900. Migula, W. System der Bakterien **2**: 554–555, 1900.
1901. Chester, F. D. A Manual of Determinative Bacteriology, p. 286, 1901.

Bacillus ruber ovatus Bruyning, 1897

Said to cause red blotches on leaves and sheaths of sorghum.

Synonymy: *Bacterium ovatum* (Bruyning) Chester.

Literature:
1897. Bruyning, F. F. La brulure du sorgho (maladie du sorgho sucre, sorghum blight, hirsebrand, sorghum-roodziekte) et les bacteries que la provoquent. Arch. Neerl. Sci. Exact. et Nat. **1**: 297–330, 1897.
1901. Chester, F. D. Manual of Determinative Bacteriology, p. 177, 1901.

Bacillus sacchari Spegazzini, 1895

Isolated from diseased sugar cane.

Smith (1914 footnote) says "This name is to be rejected on account of the earlier *Bacillus sacchari* Janse (1891)."

Spegazzini (1896) says the organism is much like *Bacillus marcescens* (Bizio) Trevisan, 1889.

Literature:
1823. Bizio, B. Polenta porporp. Biblioteca italiana o sia Giornale di lettera, scienza ed arti. 30–275, 1823. (Reference from Buchanan, General Systematic Bacteriology.)
1889. Saccardo, P. A. Sylloge Fungorum **8**: 976–977, 1889. *Bacillus marcescens* (Bizio) Trevisan. *Serratia marcescens* Bizio in Biblio. Ital. **30**: 288, 1823.
1895. Spegazzini, Carlos. La Gangrena Humeda O'Polvillo de la caña de Azúcar en Tucuman. La Plata, June 15, 1895.
1896. Spegazzini, C. Hongos de la caña de azucar. Revista de la Facultao de Agronomía y Veterinaria, La Plata. Ano II No. 19: 238, 1896. He says that from the taxonomic standpoint *Bacillus sacchari* Spegazzini is very near to *Bacillus marcescens* (Bizio) Trevisan (the marvellous *Micrococcus prodigiosus* Cohn of the authors).
1914. Smith, E. F. Bacteria in Relation to Plant Diseases **3**: 75–76, 1914.

Bacillus saccharalis Owen, 1916

Isolated from cane-borer holes in sugar cane.

Literature:
1916. Owen, W. L. A new species of alcohol forming bacterium isolated from the interior of stalks of sugar cane infested with the cane-borer *Diatroea saccharalis*. Journ. Bacter. **1**: 235–246, 1916.

Bacillus subtilis (Ehrenberg) Cohn, 1872

Isolated from rotted beet roots infected with *Rhizoctonia betae.*
Synonymy:
Vibrio subtilis Ehrenberg, 1833.
Literature:

1833. Ehrenberg, C. G. Abhandl. Berl. Akad., 145–336, 1833.
1872. Cohn, F. Untersuchungen über Bakterien. Beitr. Biol. Pflanz. 1: 174, 1872.
1891. Pammel, L. H. Fungus diseases of sugar beet. Iowa Agr. Exp. Sta. Bul. 15: 248, 1891. He attributes the disease to *Rhizoctonia betae* followed by bacteria. *B. subtilis* among others was isolated but pure culture inoculations gave no decisive results.
1912. Smith, E. F. A new method in bacterial research. Phytopath. 2: 214–215, 1912.

Said to cause decay of potato tubers at high temperatures.

1902. van Hall, C. J. J. *Bacillus subtilis* (Ehrenberg) Cohn und *Bacillus vulgatus* (Flügge) Mig. als Pflanzenparasiten. Centralb. f. Bakt. 9: 642–652, 1902.
1911. Smith, E. F. Bacteria in relation to plant diseases 2: 50, 1911.

Isolated from cultures of *Bacterium tumefaciens* and said to cause tumor growths on slices of beets.

1917. Blumenthal, F., and H. Hirschfeld. Untersuchungen über bosartig Geschwulste bei Pflanzen und ihre Erreger. Zeitsch. f. Krebsforsch. 16: 51–58, 1917.

Said to cause rotting of beet seedlings at high temperatures.

1899. Linhart, G. Krankheiten des Rubensamens. Centralb. f. Bakt. 2 abt. 5: 221–222, 1899.
1899. Stoklasa, J. Welchen Einfluss haben die Samenknauel auf die Entwicklung der Zuckerrube? Centralb. f. Bakt. 2 abt. 5: 720–726, 1899, and Zeitschr. f. Zuckerindustr. in Böhmen. 23: 646–655, 1899.
1923. von Wolzogen-Kuhr, C. A. H. Onderzoekingen aangaande de mikroflora aanwezig in normal en serehziek suikerriet. Mededeel. Proefstat. Java Suikerind. 9: 321, 1923. He isolated *Bacillus subtilis* from healthy sugar cane plants.

Bacillus tumescens Zopf, 1883

Isolated from cooked slices of moor beet held in a damp chamber.
Literature:

1883. Zopf, W. Die Spaltpilze, pp. 66–67, 1883.
1888. Koch, A. Ueber Morphologie und Entwickelungsgeschichte einiger endosporer Bakterienformen. Bot. Zeitung 46: 314–318, 1888.

Bacillus vascularum solani Tryon, 1895

Said to cause a sudden wilting of foliage and finally of the whole plant and a soft white rot of the tuber of potato.

Tryon (1895) says the disease is probably identical with that described by Smith as due to *Bacillus solanacearum.*

Smith (1914) says this is a trinomial without description of organism or proof of pathogenicity and no careful description of the disease.

Literature:

1895. Tryon, H. Gumming of cane. Ann. Rept. Queensland Dept. Agric. for 1894–1895, Brisbane 1895.

1914. Smith, E. F. Bacteria in relation to plant diseases **3:** 207–208 1914.

Bacillus vitis Montemartini, 1913

Motile; 0.75–1.0μ long; chains; Gram positive; aerobic and facultative anaerobic; white on agar, gelatin and potato and the agar becomes greenish; gelatin slowly liquefied; milk coagulated.

Said to cause weak, poorly developed grape vines with an abnormal number of shoots. In the wood of larger stems and roots occurred dark spots of irregular form and distribution and from a few millimeters to several centimeters in diameter. From such spots Montemartini isolated his organism.

No inoculations were made.

Literature:

1913. Montemartini, L. Un nuovo schizomicete della vite. Rivista de Patologia Vegetale. Anno 6, num. **6:** 171–176, 1913.

Bacillus vitivorus Baccarini, 1893

0.5 x 1.2–2.0μ; motionless or nearly so; gelatin liquefied and stained brown.

No plates were poured but he reports that inoculations were successful.

For discussion, symptoms and literature see *Bacterium gummis.*

Bacillus vuillemini Trevisan, 1889

Said to cause galls on branches of *Pinus halepensis.*

Infection could not be induced either by pure culture inoculation or by transfers of pieces of tumor tissues.

Synonymy:

Bacterium pini (Vuillemin) Chester, 1897.
Bacterium pini (Vuillemin) Migula, 1900.
Bacillus pini (Vuillemin) Ferraris, 1913.
Pseudomonas pini (Vuillemin) Petri, 1924.

Literature:

1888. Vuillemin, Paul. Sur une bactériocécidie ou tumeur bacillaire du pin d'Alep. Compt. Rend. Acad. Sci. (Paris) **107:** 874–876, 1888.

1888. Vuillemin, Paul. Sur les relations des bacilles du Pin d'Alep avec les tissus vivants. Compt. Rend. Acad. Sci. (Paris) **107:** 1184–1186, 1888.

1889. Saccardo, P. Sylloge Fungorum **8:** 982, 1889.

1889. Trevisan, V. I generi e le specie delle Batteriacee, p. 19, 1889.

1897. Chester, F. D. A preliminary arrangement of the species of the genus *Bacterium.* Ann. Rept. Delaware Col. Agr. Exp. Sta. 9: 53–145, 1897.
1900. Migula, W. System der Bakterien **2**: 512, 1900.
1913. Ferraris, T. I Parassiti vegetali delle piante coltivate od utile, p. 84, 1913.
1913. Vuillemin, Paul. Les Tumeurs des Plantes comparées aus Tumeurs Animales. Biologica (Rev. Sci. du Medecin) No. 28: 101–109, 1913.
1924. Petri, L. I tumori batterici del pino d'Aleppo. Ann. Ist. Supt. For. Naz. Firenze **9**: 187–229, 1924.
1925. Dufrénoy, J. Les tumeurs des resineux. Ann. Inst. Nat. Agron. **19**: 33–201, 1925. *Pseudomonas pini* is thought to be the cause of tumors of *Pinus cembra* and *Pinus halepensis.* Pure cultures of the organism were isolated from the latter but no results of inoculations are given.

Bacillus vulgaris (Hauser) Migula, 1900

Said to cause tuber rot of potato.
Synonymy: *Proteus vulgaris* Hauser, 1885.
Literature:

1885. Hauser. Ueber Faulnisbakterien. pp. 12, 66, Leipzig 1885.
1900. Migula, W. System der Bakterien **2**: 707–708, 1900.
1913. Cook, M. T. Report of the Plant Pathologist of the New Jersey Agric. Col. Exp. Sta., 808, 1913.

Bacillus vulgatus Trevisan, 1889

Said to cause rotting of potato tubers and beet seedlings at high temperatures.
Synonymy:
Bacillus mesentericus vulgatus Flügge, 1886.
Bacillus vulgatus (Flügge) Migula, 1900.
Literature:

1886. Flügge, C. Die Mikroorganismen **2**: 322–323, 1886.
1889. Trevisan, V. I Generi e le Specie delle Batteriacee, p. 19, 1889.
1899. Linhart, G. Krankheiten des Rubensamens. Centralb. f. Bakt. 2 abt. **5**: 221–222, 1899.
1899. Stoklasa, J. Welchen Einfluss haben die Samenknauel auf die Entwicklung der Zuckerrube? Centralb. f. Bakt. 2 abt. **5**: 720–726, 1899, and Zeitschr. f. Zuckerindustr. in Böhmen. **23**: 646–655, 1899.
1900. Migula, W. System der Bakterien **2**: 556, 1900.
1902. van Hall, C. J. J. *Bacillus subtilis* (Ehrenberg) Cohn und *Bacillus vulgatus* (Flügge) Migula als Pflanzenparasiten. Centralb. f. Bakt. **9**: 642–652, 1902.
1911. Smith, E. F. Bacteria in relation to plant diseases **2**: 50, 1911.
1915. Serbinoff, I. L. Bacterial Diseases of Potato. Journal "Diseases of Plants" **9**: 13–38, 1915. (In Russian.)

1908. Swellengrebel, N. H. Sur la nature et les causes de la maladie des taches en couronne chez la pomme de terre. Archives Néerland. Sci. Exact. et Natur. **13**: 151–195, 1908.

Bacillus zingiberi Uyeda, 1909

Associated with *Pseudomonas zingiberi* on ginger.

Literature:

1909. Uyeda, U. (Studies on soft rot of ginger or "maybyo.") (In Japanese.) Rept. Imp. Agr. Exp. Sta. Japan. No. 35: 105–140, 1909.

Bacterium acaciae R. G. Smith, 1902

Isolated from acacia twigs.

Literature:

1902. Smith, R. G. The bacterial origin of the gums of the Arabin group. Proc. Linn. Soc. N. S. Wales, **27**: 383, 1902.

1903. Smith, R. G. The bacterial origin of the gums of the Arabin group. Centralb. f. Bakt. **10**: 61–63, 1903.

Bacterium allium Griffiths, 1887

Isolated from rotting onions. No inoculations were made.

Literature:

1887. Griffiths, A. B. A new microorganism. Proc. Roy. Soc. Edinburgh **15**: 40–41, 1887.

Bacterium apii Brizi, 1896

This organism was isolated from the petioles of celery showing rusty red sunken spots and large red scabs with hyaline margins. No inoculations were made and flagella were not stained. The organism is very imperfectly described.

Synonymy: *Bacillus apii* (Brizi) Migula, 1897.

Literature:

1896. Brizi, U. V. Bacteriosi del sedano. Lavori e Relaz. della Reg. Staz. di Patol. Veg. Rome, Gennaio-Giugno 15–16, 1896.

1897. Brizi, U. La bacteriosi del sedano. Atti R. Accad. Naz. Lincei Rend. Cl. Sci. Fis., Mat. e Nat. **6**: ser. 5, fasc. 6, 229–234, 1897.

1897. Brizi, U. Una malattia bacterica dell' *Apium graveolens* L. Centralb. f. Bakt. **3**: 575–579, 1897.

1900. Migula, W. System der Bakterien **2**: 778, 1900.

Bacterium aurantium-roseum Honing, 1912

Associated with bacteria causing wilt of tobacco.

Literature:

1912. Honing, J. A. Over rottingsbacterien uit slijmzieke tabak en djatti en enkele andere van slijmziekte verdachte planten. Mededeel. van Het Deli Proefstation te Medan. Jaargang **7**: 6e aflev., 223–253, 1912.

1913. Honing, J. A. Über Faulnisbakterien aus kranken Examplaren von einigen tropischen Nutzpflanzen (tabak, sesam, erdnuss, djatti und *Polygala butyracea* Heckel). Centralb. f. Bakt. 37: 364–384, 1913.

Bacterium betae Chester, 1897

Isolated from beet roots showing a slight discoloration of the vascular tissue and a crinkling, dwarfing and yellowing of the leaves, accompanied by decreased sugar content.

Synonymy: *Bacillus arthuri* Migula, 1900. Chester (1897) named this organism from the work of Arthur and Golden. Migula named the same organism in 1900. In his 1901 Manual, Chester does not mention this organism or *Bacillus arthuri* Migula. Results of inoculation were not satisfactory.

Literature:

1892. Arthur, J. C. and K. E. Golden. Diseases of the sugar beet root. Purdue Univ., Agric. Exp. Sta. Lafayette Ind., Bul. 39: 54–58. 61–62, 1892.

1896. Smith, E. F. The bacterial diseases of plants: a critical review of the present state of our knowledge. American Naturalist 30: 723–729, 1896.

1897. Chester, F. D. A preliminary arrangement of the species of the genus *Bacterium*. Ann. Rept. Delaware Col. Agric. Exp. Sta. 9: 53–145, 1897.

1900. Migula, W. System der Bakterien 2: 681–682, 1900.

1928. Stapp, C. Schizomycetes (Spaltpilze oder Bakterien) 2 (fünfte auflage): 89, 1928.

Bacterium bolleyi Roze, 1896.

Potato scab was attributed by Bolley to bacteria in 1890 but he did not name the organism he described. He later accepted Thaxter's classification of the causal organism as *Oospora scabies*. Güssow transferred the organism from the genus *Oospora* to *Actinomyces scabies*. This is a genus of doubtful position, sometimes included among the higher bacteria and by others classed with the fungi (Hyphomycetes).

Synonymy: *Bacterium solani* Bolley (Voglino, 1905).

Literature:

1890. Bolley, H. L. Potato scab: a bacterial disease. Agric. Sci. 4: 243–256, 277–287, 1890.

1892. Thaxter, R. The potato "scab." Connecticut Agr. Exp. Sta. Rept. for 1891: 153–161, 1892.

1895. Bolley, H. L. Potato scab (*Oospora scabies* Thaxter). North Dakota Agr. Exp. Sta. Bul. No. 19: 130–134, 1895.

1914. Güssow, H. T. The systematic position of the organism of the common potato scab. Science n.s. 39: 431–433, 1914.

Bacterium briosianum Pavarino, 1911

Said to cause small, raised, irregular, pitch-black leafspots without halo or border, and bleached elongated lesions on the petioles which extend down onto the branches, causing them to blacken and die.

It is not certain from his description of isolations that he was working with pure cultures. The organism is imperfectly described. Motility and flagellation are not mentioned.

Literature:

1911. Pavarino, G. L. Batteriosi della "*Vanilla planifolia*" Andr. (*Bacterium briosianum* n. sp.). Atti della Reale Accad. Naz. Lincei Rend. Cl. Sci. Fis., Mat. e Nat. **20**: 161–162, 1911. Also the same article in Istituto Botanico della R. Universita di Pavia, Ser. II, **15**: 86–88, 1918.

Bacterium castanicolum Cavara, 1914

This organism was isolated from galls at the bases of stems of chestnut seedlings. No inoculations were made.

Literature:

1914. Cavara, F. Di una nuova malattia del castagno. Rivista di Patologia Vegetale **7**: 1–5, 1914. Reviewed in Centr. Bakt. 2, **53**: 214–215, 1921.

Bacterium corylli Brzezinski, 1903

Isolated from cankers and tumors on old hazelnut trees. Brzezinski says this organism is the same culturally and morphologically as *Bacterium mali*. He gives no results of inoculations.

Literature:

1903. Brzezinski, M. J. Le chancre des arbres, ses causes et ses symptoms. Bul. Internat. de L'Acad. des Sci. de Crocovie., Classe des Sci. Math. et Nat., 139–140, Mars 1903.

Bacterium deliense Honing, 1912

Associated with bacteria causing wilt of tobacco.

Literature:

1912. Honing, J. A. Over rottingsbacterien uit slijmzieke tabak en djatti en enkele andere van slijmziekte verdachte planten. Mededeel. van Het Deli Proefstation te Medan Jaargang **7**: 6e aflev., 223–253, 1912.

1913. Honing, J. A. Über Faulnisbakterien aus kranken Examplaren von einigen tropischen Nutzpflanzen (tabak, sesam, erdnuss, djatti und *Polygala butyracea* Heckel). Centralb. f. Bakt. **37**: 364–384, 1913.

Bacterium dianthi Arthur and Bolley, 1896

"Isolated from carnations (*Dianthus* spp.), and supposed to be the cause of a spot disease, common on the surface of carnation leaves, but now believed to be purely saprophytic." Smith, 1901.

Curly top of beets, a virus disease, was at one time attributed to this organism.

Synonymy:

Pseudomonas dianthi (Arthur and Bolley) E. F. Smith, 1901.
See *Bacterium woodsii.*

Literature:

1889. Arthur, J. C. A bacterial disease of carnations. Proc. American Assoc. Adv. Sci. for 1889, 38: 280, 1889. (Abstr. of paper read at Toronto Aug., 1889.) This is the first paper ascribing spot disease of carnations to bacteria.

1890. Arthur, J. C., and H. L. Bolley. The specific germ of the carnation disease. Proc. American Assoc. Adv. Sci. for 1890, 39: 334, 1890. (Abstract.)

1892. First Annual Report American Carnation Soc. for 1891, 92: 52, 1892.

1894. Halsted, B. D. A bacterial disease of the carnation. Ann. Rept. New Jersey Agric. Exp. Sta. 14: 387–388, 1894. The same disease as that described by Arthur and Bolley.

1894. Arthur, J. C. Discrimination of diseases without the use of the microscope. Ann. Rept. American Carnation Soc. for 1894: 12, 1894.

1894. Arthur, J. C. The discrimination of diseases without the use of a microscope. The American Florist 9: 647, 1894.

1896. Arthur, J. C., and H. L. Bolley. Bacteriosis of carnations. Purdue Univ. Agr. Exp. Sta. Bul. 59: 17–38, 1896.

1897. Woods, A. F. Bacteriosis of carnations. Bot. Gaz. 24: 188, 1897. Abstract of paper read at Detroit Meeting.

1897. Woods, A. F. Bacteriosis of carnations. Centralb. f. Bact. 3: 722–727, 1897. Also in Bot. Gaz. 24: 200–205, 1897. Abstract in Proc. American Assoc. Adv. Sci., 273–274, 1897. From repeated experiments with aphids he found that "the insects alone were capable of producing the disease and that neither fungi nor bacteria were present until the malady was well advanced, and in such cases not regularly nor constantly present." Infection experiments with such organisms resulted negatively in every case.

1900. Woods, A. F. Stigmonose: A disease of Carnations and other Pinks. U. S. Dept. Agric., Div. Veg. Phys. and Path. Bul. 19: 7–30, 1900. "This bulletin gives the results of many additional observations and experiments, all of which are confirmatory of the author's earlier conclusion, viz., that this disease is not of bacterial origin, but due to injuries made by aphides, thrips, and red spiders. The thoroughness of this paper deserves special commendation."

1901. Smith, E. F. The cultural characters of *Ps. campestre*, *Pseudomonas hyacinthi*, *Ps. phaseoli*, and *Ps. stewarti*—four one-flagellate yellow bacteria parasitic on plants. U. S. Dept. Agric., Div. Veg. Phys. and Path. Bul. 28: 153, 1901.

1907. Smith, R. E. Beet blight investigation. California Agr. Exp. Sta. Bul. 184: 240, 1907.

1908. Townsend, C. O. Curly top, a disease of the sugar beet. U. S. Dept. Agr., B. P. I. Bul. 122: 7–32, 1908.

1915. Smith, R. E., and A. Boncquet. New light on curly top of the sugar beet. Phytopath. 5: 103–107, 1915. An organism agreeing with *Bacillus dianthi* Bolley, was found in the diseased tissue.

1915. Smith, R. E., and P. A. Boncquet. Connection of a bacterial organism with curly leaf of the sugar beet. Phytopath. 5: 335–341, 1915. *Bacillus dianthi* found constantly associated with distorted or abnormal beet leaves, but all efforts to produce curly leaf or other abnormal conditions by inoculation with this organism failed.

Bacterium eucalypti R. G. Smith, 1902

Isolated from the gummy exudate of *Eucalyptus stuartiana.*

Literature:

1902. Smith, R. G. A gum (Levan) bacterium from a saccharine exudate of *Eucalyptus stuartiana.* (*Bacterium eucalypti* n. sp.) Proc. Linnean Soc. N. S. Wales, Part, 2, June 25, 1902.

Bacterium fluorescens (Flügge) Lehmann and Neumann, 1896

Said to cause rotting of cabbage, barley seedlings, beet seedlings, potato, tobacco and celery.

Synonymy:

Bacillus fluorescens liquefaciens Flügge, 1886.

Bacillus fluorescens nivales Schmolck, 1888 (according to Migula and Eisenberg).

Pseudomonas fluorescens (Flügge) Migula, 1900.

Bacterium fluorescens liquefaciens (Flügge) Zikes, 1910.

See *Bacillus caulivorus* Prillieux et Delacroix.

Literature:

1886. Flügge, C. Die Mikroorganismen 2nd ed., 289, 1886.

1891. Eisenberg, J. Bakteriologische Diagnostik, p. 77, 1891.

1896. Lehmann, K. B., und R. Neumann. Bakteriologie 10: Teil 2, 272–273, 1896.

1899. Laurent, E. Recherches experimentale sur les maladies des plantes. Ann. a l'Inst. Pasteur 13: 36, 1899. He ascribed the disease to *Bacillus fluorescens liquefaciens.* He states that it is quite diferferent from *Bacillus solancearum.*

1899. Linhart, G. Krankheiten des Rubensamens. Centralb. f. Bakt. 2 abt. 5: 221–222, 1899.

1899. Stoklasa, J. Welchen Einfluss haben die Samenknauel auf die Entwickelung der Zuckerrube? Centralb. f. Bakt. 2 abt. 5: 720–726, 1899. Zeitschr. f. Zuckerindustr. in Böhmen. 23: 646–655, 1899.

1900. Migula, W. System der Bakterien 2: 886–888, 1900.

1902. Lepoutre, M. L. Recherches sur la transformation experimentale de bacteries banales en races parasites des plantes. Annales de L'Institut Pasteur 16: 304–312, 1902.

1904. Barlow, B. A rot of celery. Ontario Agric. College Bul. 136: 19–20, 1904. It only attacks celery in storage when its resistance has been lowered by low temperature.

1909. Griffon, E. Sur le role des bacilles fluorescents de Flügge en pathologie vegetale. Compt. Rend. Acad. Sci. (Paris) **149**: 50–53, 1909.

1910. Zikes, H. Über Bakterienzoogloenbildung an den Wurzeln der Gerstenpflanze. Zeitschr. f. das Gesamte Brauwesen. **33**: 357–360, 1910.

1915. Serbinoff, I. L. (Bacterial diseases of the potato.) Journal "Diseases of Plants" **9**: 13–38, 1915. (In Russian.)

Bacterium gelatinosum betae Glazer, 1895

Isolated from beet root juice expressed for sugar manufacture.

Literature:

1895. Glazer. Zur Gallertausscheidung in Rubensaften. Centralb. f. Bakt. **1**: 879–880, 1895.

Bacterium gracile Costa, 1880

This name was published without description by Costa as follows: "Il Prof. Comes La definito questo Bacterio per il *Bacterium gracile.*"

It was seen in the gum of the vine. (From Come's Crittogamia Agraria 1891.)

For discussion, symptoms and literature see *Bacterium gummis.*

Bacterium gummis Comes, 1884

Described by Comes in Crittogamia Agraria 1891.

"Very short, elliptical bacilli, 0.6–1.5 x 0.4–1.2μ; for the most part isolated, and sometimes arranged in pairs or in heaps."

Synonymy:

Bacillus gummis (Comes) Trevisan, 1889.

Bacillus gummis (Comes) Migula, 1900.

Bacterium gummis, *Bacterium gracile*, *Bacillus vitivorus* and *Bacillus baccarinii* have all been named as the cause of mal nero of the vine (*Vitis* sp.) but in spite of the numerous microscopic examinations and of the cultures and inoculations made by various persons, the etiology of this disease is still to be determined. Several diseases may have been confused along with the normal gum formation of wounded vines.

Symptoms: The principal symptoms are brownish-black stripes on the branches which become more pronounced and progress from the top to base of the vine. Tissues under the stripes collapse and crack in some cases in as far as the pith. A gummy substance fills the vessels. Leaves may be blackened or covered with brown spots and flowers and fruit may be malformed. Affected plants are stunted, have short internodes and poorly developed foliage. Infected plants usually die in about five years.

Literature: The notes under literature are taken from an unpublished review by Dr. Erwin F. Smith.

1879. Garovaglio, S. e A. Cattaneo. Studj sulle dominanti malattie dei vitigni. II Del. Mal Nero. Arch. Labor. Bot. Critt. Univ. Pavia, 2e **3**: 252–261, 1879. Garovaglio and Cattaneo are said to be the first to find bacteria associated with Mal nero. They found the bacteria in large numbers in the scalariform vessels of the fibrovascular bundles of the wood but considered them only secondary

to a disturbed process of nutrition. They obtained their material from diseased vines from the vicinity of Naples, Syracuse and Catania.

1880. Costa. Lezioni di Entomologia Agraria, Autografia, p. 437, 1880. (Original not seen—from Dr. Smith's notes.)

1880. Trevisan, V. Il mal nero e la Fillossera a Valmadrera. Reale Istituto Lombardo di Scienze e Lettere. Rendiconti. Ser. II, **13**: 7–14, 1880. "Trevisan's contributions to this subject were the discovery of "Endocysts" (the tyloses); of fine granules; and following Garovaglio, of bodies which he also identified as bacteria. These latter occurred in the vessels along with the "Endocysts" and the granules."

1881. Cugini, Gino. Ricerche sul Mal nero della vite. Memorie della Societa Agraria di Bologna. **21**: p. 36, 1881. (Reprinted in transl. in La Vigne Americaine. Reviewed in Bot. Centralb. **8**: 147–148, 1881.) "Cugini, between 1881 and 1892 contributed various papers on Mal nero but none of any importance so far as the etiology is concerned. He appears to have worked for the most part, if not altogether, at a distance from the disease, on fragments sent in to him. His papers are quite full on signs of the disease, taken, however, largely at second hand, and agreeing in the main with Baccarini's which were drawn from systematic field observations." At first Cugini attributed Mal nero to fungus parasites. When Baccarini had reached the conclusion that Mal nero was due to bacteria, Cugini published a paper (1892) in which he states that he also has found bacteria in diseased vines and perhaps in advance of Baccarini. These bacteria were isolated from the blackened wood of vines sent to him. Pale yellow (fluorescent) colonies developed on gelatin, on agar colonies are small, raised, gray. The organism is aerobic, motile, single or in chains, 2.25–6.0 x 0.75μ. No inoculations were made.

1882. Garovaglio, S. La Vite e i Suoi Nemici nel 1881. Arch. Laboratorio Botanica Crittoganica di Pavia. Milano **4**: 183–195, 1882. He defines Mal nero as a disease which directly attacks the wood proceeding from trunk to roots. Interrupted streaks of a black color appear in the wood, first in the upper part and then lower down as the disease progresses. Bacteria fill the vessels in these black streaks.

1882. Comes, O. Primi risultati degli sperimenti fatti per la cura della gommosi o Mal nero della vite in Sicilia. L'Agricoltura Meridionale, p. 173, Aug., 1882. (From Baccarini, 1893.) That the idea of infertility of the soil as the cause of Mal nero was still in his mind is shown in his second paper, Aug., 1882, in which he describes experiments with fertilizers and claimed good results for wood ashes.

1882. Comes, O. Il Mal nero della vite. L'Agricoltura Meridionale, Portici, p. 65, Feb., 1882. (From Baccarini, 1893.) "Comes' first paper on Mal nero (Feb., 1882), took the view that the

disease was a non-parasitic gummosis due to defective soil conditions. His studies were made on vines sent from Sicily. The yellow and brown substance in the diseased wood-tissues is declared to be gum. Viscid, transparent, pale yellow gum, often oozes from the cut surface of young diseased stems. All the starch degenerates into gum in the changed portions of the trunk. He says "already in the volcanic districts of Sicily, in a restricted area, they reckon by thousands the vines destroyed by this disease."

1882. Comes, O. Sul preteso tannino scoperto nelle vite affete da Mal nero. L'Agricoltura Meridionale, p. 202, Nov., 1882. (From Baccarini, 1893.) "At the close of this paper, vine gummosis is stated to be an infectious disease which never appears except in connection with root rot due to bacteria. The bacteria are now supposed to be the cause of the contagion.

1884. Comes, O. Il marciume della radici e la gommosi della vite. Napoli, p. 14, 18 Maggio, 1884. *Bacterium gummis.* Comes here declares Mal nero to be due to a root rot which induces the gummy degeneration in the roots and also in tissues above ground. The infectious substance is the gum which is always present in diseased tissues. Artificial inoculation experiments with gum made him conclude that the infectiousness was due solely to the gum. He claims to have reproduced the disease by inoculating with (1) gum of the vine, (2) gum of cherry, (3) gum of fig, (4) gummy tissue of the vine stem and root. None of his experiments are described. The actual cause of the disease is a microorganism peculiar to the gum which is named *Bacterium gummis* without description.

1885. Comes, O. Il Mal nero o la gommosi nella vite ed in qualsivoglia altra pianta legnosa e gli eccessivi sbalzi di temperatura. Ann. R. Scuola Sup. Agr. Portici 5: 71–94, 1885. (From Baccarini, 1893.) Mal nero is ascribed to sudden great fluctuations of temperature during the winter. In this paper *Bacterium gummis* plays but an insignificant rôle, although incidentally he still maintained the gum to be due to it.

1885. Corvo, L. de A. Sur le role des bacilles dans les ravages attribués au *Phylloxera vastatrix.* Compt. Rend. Acad. Sci. (Paris) **101**: 528–530, 1885.

1889. Trevisan, V. I generi e le specie delle Batteriacee Milano, p. 17, 1889. *Bacillus gummis*, Trev. (*Bacterium gummis* Comes). No description of organism.

1891. Baccarini, P. I. Intorno ai caratteri proprii di alcune malattie della vite. Bulletino del Com. Agr. di Acireale, p. 153, 1891. (From Baccarini, 1893.) The beginning of Baccarini's researches. His studies were in the region of Aetna, Sicily where he saw thousands of diseased plants.

1891. Comes, O. Crittogamia Agraria Napoli, pp. 349–351, 431–433, 498–500, 1891. In 1891, Comes describes *Bacterium gummis* as follows: *Bacterium gummis* Comes. Very short, elliptical bacilli, 0.6–

1.5 x 0.4–1.2μ, for most part isolated, and sometimes in pairs or in heaps. Translation. "Lives in the mucilage which precedes the gummifaction of starch-bearing cells in the plants affected by gummosis. Perhaps these are the bacteria mentioned by Garovaglio (1878), but which by the writer were named *Bacterium gracile* (1880), and then *Bacterium gummis* (1884). Inoculations made with the same bacterial mucilage have always produced a gummy focus while uninoculated check wounds have promptly healed. Inoculations made with the bacteria cultivated from the gum in sterilized chicken broth also succeeded easily."

1892. Baccarini, Pasquale. Sul Mal nero delle viti in Sicilia. Nota preliminare, Malpighia **6**: 229–234, 1892. The same paper in full in Boll. di Not. Agr., **14**: 326–329, 1892. Rev. in Zeitsch. f. Pflantzenkr. **3**: 114, 1893. Baccarini's conclusions respecting Mal nero, as set forth in Malpighia are as follows: (literal translation). The Mal nero of vines in Sicily is due to the parasitism of a Schizomycete which grows by preference in tissues rich in protoplasm and plastic substances, such as the cambium, the medullary rays, the cortical parenchyma and the phloem of the organs of the attacked plants.

1892. Cugini, G. Intorno ad una specie di bacillo trovato nel legno delle vite affette da Mal nero. Le Staz. Sperim. Agr. Ital. **23**: 44–48, 1892. He states that he found bacteria in diseased vines and perhaps in advance of Baccarini.

1893. Baccarini, P. Il Mal nero della vite (*Bacillus vitivorus*). Staz. Sperimen. Agrarie Ital. **25**: 444–510, 1893. (Published Oct. 8, 1894 according to L. Macchiati, one of the associate editors of this Journal.) *Bacillus vitivorus*. Rev. in Zeitschr. f. Pflanzenkr. **4**: 349, 1894. This paper deals with previous literature, signs, pathological histology, culture methods, inoculations etc. Cavities are formed in the tissue, these and the lumen of vessels are filled with bacterial slime. The bacilli are 1.5–2.0 x 0.5μ; liquefy gelatin which acquires a brownish color and a slight fluorescence. Attempts to infect uninjured tissue failed. Six inoculation experiments made by breaking the tissues were successful, the inoculated shoots developing typical Mal nero cankers. The checks remained healthy. It does not appear that the organism was reisolated from the infected shoots. Baccarini appears to have made out a probable case but the evidence does not appear to be entirely conclusive. Baccarini describes in detail the appearance of diseased vines. The signs are delay in unfolding of buds in spring, short internodes, leaves small, wrinkled and sometimes blackened on the margin, stems rigid and brittle with black depressed cankerous stripes along one side, abnormal flowers and fruits. The development of great numbers of adventitious shoots which he describes is not peculiar to Mal nero. It is likely that infection takes place through wounds due to pruning.

Baccarini concludes that Mal nero consists of a pathological process peculiar to the aerial organs of the vine. It becomes evident externally by the rachitis of sprouts in Spring, by the appearance of numerous floral anomalies, of black stripes and of genuine cankers on the herbacious organs of the plant. The woody branches, the upper stems, the trunk and in the final stage, the roots show in their woody tissues black stripes which usually extend toward the base of the plant, and a profound disintegration of the elements in the generative layer and cortex, laying the wood bare.

1894. Baccarini, P. Sul Mal nero delle viti. Bul. della Soc. Bot. Ital. 7 Guigno, Florence, 228–237, 1894. *Bacillus vitivorus* n. sp. first mentioned here, p. 235.

1894. Comes, O. Mal nero o gommosi della vite. Atti del R. Istituto d'Incoraggiamento di Napoli 7 (No. 9): 1–8, 1894. *Bacterium gummis*. A review of the work done on gummosis of vine.

1894. Foex, G., et P. Viala. Maladies de la vigne dans le Var. Revue de Viticulture du 21 Juillet 2: 53–57, 1894. They isolated bacteria several times from vines attacked by gelivure which may or may not be Mal nero. Inoculations were not successful. Only young shoots were attacked. The ends become blackened, the nodes swollen, longitudinal brown stripes appear on woodier shoots which split open.

1894. Foex, G., et P. Viala. La gelivure de la vigne. Revue de Viticulture 1: No. 6, 129–131, 153–160, 1894.

1894. Le Cocq, A. C. Relatorio acerca da doenca das vinhas do douro denominada Maromba. Buletim da Direcção Geral de Agricultura Lisbon quinto anno, N. 13: 1059–1177, 1894. Le Cocq considered the Portuguese disease Maromba identical with Mal nero of the Italians. It does not appear from his paper that he made any pure cultures or any inoculations.

1894. Mangin, L. Sur la presence de thylles gommeuses dans la Vigne. Compt. Rend. Acad. Sci. (Paris) 119: 514–516, 1894. Also in Jour. Agric. Prat. 2: 459–461, 1894, and Rev. Internat. Vitic. et d'oenol. 1: 339, 1894. He thinks it is very doubtful that bacteria are the cause of Mal nero of the vine. He found no bacteria except in wounded parts exposed to contagion.

1894. Prillieux, E., et G. Delacroix. La gommose bacillaire des vignes. Compt. Rend. Acad. Sci. (Paris) 118: 1430–1432, 1894. The same paper in Revue de Viticulture 2: 5–7, 1894. See also Revue Internationale de Viticulture et d'Oenologie. 1: 315–318, 1894, and Revista di Pathologia Vegetale 3: 105–106, 1894. This note closes as follows: "A portion of a vine from Italy attacked by Mal nero, which we possess in the collections of vegetable pathology and whose authenticity is certain, shows on microscopic examination the same characteristics as those of French vines attacked by bacillary gummosis. We believe that we must admit the identification of Mal nero of the Italians with the bacillary

gummosis of the French vines which the vinyardists have already observed in our country, and which they have designated by various names, without knowing the true nature of it."

1894. Prillieux, E., et G. Delacroix. Maladie bacillaire des vignes du Var. Bul. Soc. Bot. France 41: 384–385, 1894.

1895. Mangin, L. Sur la gommose de la vigne. Rev. de Viticulture. Nos. 55–56, 3: 5–12, 29–35, 1895. He examined specimens from sections where the disease was severe and came to the conclusion that normal gummosis is independent of any parasitic action, fungus or bacterial.

1895. Ravaz, L. La maladie des vignes de l'Ile D'Oléron. Rev. Viticulture 4 (No. 85): 101–103, 1895. He found bacteria abundant in the vessels and states that he reproduced the disease by inoculation. The organism is described as aerobic, 1.5–2.5μ in length.

1896. Prillieux, E., et G. Delacroix. La gommose bacillaire. Maladies des vignes. Ann. d L'Inst. Nat. Agron. No. 14, 1891–1892: 31–59, 1896. Known in France as aubernage, roncit, in Italy as Mal nero. He thinks this disease is due to *Bacillus vitivorus* Baccarini.

1896. Rathay, E. Erklärungen bezüglich der "Gommose bacillaire." Die Weinlaube. 28: 49–50, 1896. "The causes which have led to the erroneous supposition of the existence of a bacillar gummosis lie in part in our ignorance hitherto concerning the gummy vessels which the healthy vine contains, in part in the non critical way in which persons have sought in diseased vines to ascribe the cause of the disease to bacteria."

1896. Rathay, E. Über das Auftreten von Gummi in der Rebe und über die "Gommose bacillaire." Jahresbr. und Programm der K. K. Önologischen und Pomologischen Lehranstalt in Klosterneuberg Wein (Separatabdruck), 1–84, 1896. Reviewed in Bot. Centralb. 67: 54, 1896. Zeitschr. f. Pflanzenkr. 7: 164, 1897. He gives a full account of the minute anatomy of the vine and of the natural occurrence of gum in the wood. He reviews the earlier literature and his general conclusion is that gum is common in the vessels of the old wood of healthy vines of all sorts, dark spots and stripes are not the signs of a disease and that bacterial gummosis does not exist.

1897. Macchiati, L. Ricerche sulla biologia del *Bacillus Baccarinii* (*Bacillus vitivorus* Baccarini). Le Stazioni Sperimentali Agrarie Italiane 30: 401–444, 1897. *Bacillus Baccarinii*, Macch. He made no inoculations, so there is no reason to believe this organism had anything to do with Mal nero. Dr. Smith examined Macchiati's sections and saw more fungus hyphae than bacteria.

1897. Macchiati, L. Sulla biologia del *Bacillus Baccarinii* (*B. vitivorus* Baccarini). Bul. della Soc. Bot. Ital., pp. 156–163, 1897. *Bacillus Baccarinii*, n. sp. He substitutes this name for *B. vitivorus* because he says no sufficient description of the other organism was given. Chains; spores; 2–3.5 x 0.65–0.8μ; capsules; Gram positive; aerobic; on agar, yellowish amber becoming grayish:

on gelatin, yellowish amber becoming straw yellow; optimum temperature 23–25°C.; maximum 39°; no growth at 40°; liquefies gelatin and makes it fluorescent; coagulates milk; diastatic action present. Mácchiati states here that his researches on Mal nero were begun in 1891. This paper deals with some features of the morphology and biology of his *Bacillus Baccarinii* but not with its pathogenic properties.

1898. Macchiati, L. Ueber die Biologie des *Bacillus Baccarinii* Macchiati. Centralblatt. f. Bakteriol. IV: 332–340, 1898. This is a translation of Macchiati's longer Italian paper.

1900. Migula, W. System der Bakterien 2: p. 778, 1900. *Bacillus gummis* Comes 1884, synonyms, *Bacillus vitivorus* Bacc. 1892, *Bacillus Baccarinii*, Macch. 1897.

1907. Korff, G. Über die "bakterielle" Gummosis des Weinstockes. Prakt. Blätt. F. Pflanzenbau und Pflanzenschutz. **10**: 97–101, 1907.

1910. Alazraqui, J. Gomosis bacilar y court-noue en los vinedos de Mendoza. Buenos Aires Min. Agr., 33 pp., 1910. *Bacillus vitivorus* said to cause the gummosis.

1912. Petri, L. Osservazioni sopra le alterazioni del legno della vite in Seguito a ferite. Staz. Sper. Agr. Ital. **45**: 501–547, 1912. In the gum of the brown streaks he found one species of bacterium which in cultural and morphological characters was the same as *Ascobacterium luteum* Babes. Inoculations did not give positive results.

1921. Mazzaccara, G. Il *Bacillus vitivorus* e il Mal nero della vite. Riv. di Agric. (Parma) **26**: 6, 1921. Found all over Italy especially in the South on American and European varieties.

1922. Cifferi, R. Il Mal nero della vite. Revista di Agricoltura Parma **27**: 378–379, 1922. *Bacillus vitivorus* Baccarini.

1923. Bergey's Manual of Determinative Bacteriology, p. 328, 1923.

1926. Ferraris, T. Trattato di Patologia e Terapia Vegetale. 3rd Edition, 1926. *Bacillus Baccarinii* Macchiati. (Syn. *Bacillus vitivorus* Baccarini.)

Bacterium hederae Arnaud, 1920

Said to cause rounded, translucent leaf spots about 5 mm. to 2 cm. in diameter. These turn brown and often have yellow halos about them. Long brown spots also are said to occur on branches of *Hedera helix* in France.

No description of the organism is given and apparently no isolations or inoculations were made.

Literature:

1894. Lindau, G. Der Ephenkrebs. Zeitschr. f. Pflanzenkr. **4**: 1–3, 1894. He describes and figures a bacterial leafspot and canker of ivy which he says is due to bacteria. He made no inoculations.

1920. Arnaud, M. G. Une maladie bacterienne du lierre (*Hedera helix* L.). Compt. Rend. Acad. Sci. (Paris) **171**: 121–122, 1920.

1921. Killian, C. Une maladie bacterienne du lierre. Compt. Rend. Soc. Biol. (Paris) **84**: 224–226, 1921.

Bacterium herbicola aureum Düggeli, 1904

Isolated from barley seeds, sugar cane, germinating plants and roots.

Literature:

1904. Düggeli, M. Die Bakterienflora gesunder Samen und daraus gezogener Keimpflanzchen. Centralb. f. Bakt. **13**: 56–63, 198–200, 1904.

1910. Zikes, H. Über Bakterienzoogloenbildung an den Wurzeln der Gerstenpflanze. Zeitschrift für das Gesamte Brauwesen. **33**: 357–360, 1910.

1923. Wolzogen Kuhr, C. A. H. Onderzoekingen aangaande de mikroflora aanwezig in normaal en serehziek suikerriet. Archief Suikerind. Nederland. Indië. Meded. Proefstat. Java suikerind **9**: 321–481, 1923. He found that the growth of healthy canes from infected setts was associated with the complete absence of *Bacterium herbicola aureum* which was originally present in the diseased parent setts.

1924. Bremer, G. Onderzoek over de afstervingstemperatuur van *Bacterium herbicola*. Meded. Proefstat. Java—Suikerind. **3**: 55–64, 1924. *Bacterium herbicola* consistently isolated from sereh infected cane by Wolzogen Kuhr was found to have a T. D. P. of about 50°C and the experiments lead to the conclusion that most if not all of the strains of the organism would be destroyed by the hot water treatment based on Miss Wilbrink's method.

Bacterium herbicola rubrum Düggeli, 1904

Isolated from barley seeds, germinating plants and roots.

Literature:

1904. Düggeli, M. Die bakterien Flora gesunder Samen und daraus gezogener Keimpflanzchen. Centralb. f. Bakt. **12**: 602–614, 1904. Centralb. f. Bakt. **13**: 56–63, 198–200, 1904.

1910. Zikes, H. Über Bakterienzoogloenbildung an den Wurzeln der Gerstenpflanze. Zeitschrift für das Gesamte Brauwesen. **33**: 357–360, 1910.

Bacterium lactescens Roze, 1897

From tubers attached by *Phytophthora* the authors describe very imperfectly another new species of Schizomycete *Bacterium lactescens*. This occurs on the softened parenchyma as a milky liquid resembling the mucus of *Micrococcus*. "It is at first a very little spherical cell (diameter 0.5μ) which becoming elliptical (length 0.75μ) immediately shows a division. It then presents chains of four and more cells."[1]

Literature:

1897. Roze, E. Sur la pourriture des pommes de terre. Compt. Rend. Acad. Sci. (Paris) **125**: 1118–1120, 1897.

1898. Roze, E. Du *Phytophthora infestans* de Bary et de la pourriture des pommes de terre. Bull. Soc. Mycol. France, **14**: 63, 1898.

Bacterium langkatense Honing, 1912

Associated with bacteria causing wilt of tobacco.

Literature:

1912. Honing, J. A. Over Rottingsbacterien uit slijmzieke Tabak en djatti en enkele andere van slijmziekte verdachte Planten. Mededeel. von Het Deli Proefstation te Medan. Jaargang **7:** 6e afl. 223–253, 1912.

1913. Honing, J. A. Über Faulnisbakterien aus kranken Examplaren von einigen tropischen Nutzpflanzen (tabak, sesam, erdnuss, djatti und *Polygala butyracea* Heckel). Centralb. f. Bakt. **37:** 364–384, 1913.

Bacterium levaniformis R. G. Smith, 1904

Isolated from peach twigs exuding gum.

Literature:

1904. Smith, R. G. The bacterial origin of the gums of the Arabin group. Centralb. f. Bakt. 2, **11:** 689, 1904.

Bacterium löhnisi Kalantarien, 1925

Isolated several times in pure culture from cotton plants showing browning of vascular tissue, wilting of leaves and final dying of entire plant. No inoculations were made.

Synonymy: *Phytomonas löhnisi*, (Kalantarien) Bergey et al., 1930.

Literature:

1925. Kalantarien, P. Zwei neue Bakteriosen der Baumwollstande in Armenien. Centralb. f. Bakt. **65:** 297–301, 1925.

1930. Bergey's Manual of Determinative Bacteriology, p. 244, 1930. (3rd. ed.)

Bacterium maidis Maiocchi, 1881

Isolated from spoiled corn and from pellagra patients.

Synonymy:

Bacterium maydis Trevisan, 1883.
Bacillus maidis (Cuboni) Paltauf-Heider, 1888.
Bacillus maidis Trevisan, 1889.
Bacillus maidis Cuboni, 1891.
Pseudomonas maidis (Cuboni) Migula, 1900.
Bacillus maidis Paltauf-Heider, 1901.
Bacillus maidis (Maiocchi) Trevisan, 1905. (The original name *Bacterium maidis* was described as motile. Later descriptions call it motile until Migula in 1900, from a culture from Tataroff, demonstrated a polar flagellum).

Literature:

1881. Maiocchi. Bullettino della Reale Accad. Medica di Roma **7:** 291–293, 1881.

1883. Trevisan, V. Il Batterio del tifo addominale (*Metallacter Ileotyphi*) e il Batterio della pellagra, (*Bacterium maydis*). Atti della Accad. Fisio-Medico-Statistica in Milano. Ser. 4, **1:** 149–157, 1883.

1888. Paltauf, R., und A. Heider. Der *Bacillus maidis* (Cuboni) und seine beziehungen zur pellagra. Medizinischer Jahrbücher **84**: 383–434, 1888.

1889. Trevisan, V. I generi e la specie delle batteriacee. 17, 1889.

1891. Eisenberg, J. Bakteriologische Diagnostik 3rd ed. 119, 1891.

1891. Tataroff, D. Die Dorpater Wasserbacterien. Inaug. Dissert. 23–24, 1891.

1900. Migula, W. System der Bakterien, **2**: 654–655, 877–878, 1900.

1901. Chester, F. D. A Manual of Determinative Bacteriology 275, 1901.

1905. Voglino, P. Patologia Vegetale. 42, 1905.

Bacterium medanense Honing, 1912.

Associated with bacteria causing wilt of tobacco.

Literature:

1912. Honing, J. A. Over Rottingsbacterien uit slijmzieke Tabak en djatti en enkele andere van slijmziekte verdachte Planten. Mededeel. van Het Deli Proefstation te Medan Jaargang **7**: 6e afl. 223–253, 1912.

1913. Honing, J. A. Über Faulnisbakterien aus kranken Examplaren von einigen tropischen Nutzpflanzen (tabak, sesam, erdnuss, djatti und *Polygala butyracea* Heckel). Centralb. f. Bakt. **37**: 364–384, 1913.

Bacterium metarabinum R. G. Smith, 1902.

Isolated from exuding gum of acacia.

Literature:

1902. Smith, R. G. The bacterial origin of the gums of the Arabin group. Proc. Linn. Soc. N. S. Wales **27**: 399, 1902.

Bacterium moniliformans Guffroy, 1901

Isolated from root swellings on oat grass, *Arrhenatherum elatius*.

Literature:

1901. Guffroy, C. L'Avoine a chapelet et le "*Bacterium moniliformans* Guff." Journ. D'Agric. Pratique Nouvelle Ser. **2**: 719–720, 1901.

Bacterium olivae Montemartini, 1914

Said to cause withering, drying and dying of leaves and young branches of olive.

Literature:

1914. Montemartini, L. Intorno ad una nuova Mallatia dell'Olivo (*Bacterium olivae* n. sp.) Atti dell' Ist. Bot. dell' Univ. di Pavia II ser. **14**: 151–158, 1914. Inoculations were not successful. Flagella not stained.

1922. Ciferri, R. Sulla batteriosi dei rami d'olivo. Il. Colt. **68**: 164–168, 1922. Ciferri considers the organism a saprophyte which enters wounds and becomes parasitic when conditions are particularly unfavorable to the host.

Bacterium pararabinum R. G. Smith, 1903

Isolated from acacia fruits containing gum.

Literature:

1903. Smith, R. G. The botanical origin of the gums of the Arabin group 10: The pararabin gum of Sterculia. (*Bacterium pararabinum* n. sp.) Proc. Linnean Soc. N. S. Wales pt. 3, 541–552, 1903.

Bacterium patelliforme Honing, 1912

Associated with bacteria causing wilt of tobacco.

Literature:

1912. Honing, J. A. Over Rottingsbacterien uit slijmzieke Tabak en djatti en enkele andere van slijmziekte verdachte Planten. Mededeel. van Het Deli Proefstation te Medan. Jaargang **7**: 6e aflev. 223–253, 1912.

1913. Honing, J. A. Über Faulnisbakterien aus kranken Examplaren von einigen tropischen Nutzpflanzen (tabak, sesam, erdnuss, djatti, und *Polygala butyracea* Heckel). Centralb. f. Bakt. **37**: 364–384, 1913.

Bacterium persicae Girardi, 1920

Said to cause tumors on peach. There is no record of inoculations and no description of the organism is given. This name was used by Smith in 1903.

Literature:

1903. Smith, R. G. A slime bacterium from the peach, almond, and cedar *Bacterium persicae* n. sp. Proc. Linn. Soc. N. S. Wales, Part 3. May 27, 1903.

1920. Girardi, J. Tumor bacteriano del duraznero. Bol. Mens Defensa Agr. Uruguay. 279–281, 1920.

Bacterium persicae R. G. Smith, 1903

Isolated from peach fruit saturated with a transparent colorless gum. There is no record of any inoculations.

Literature:

1903. Smith, R. G. A slime bacterium from the peach, almond and cedar, *Bacterium persicae* n. sp. Proc. Linn. Soc. N. S. Wales, Part 3, May 27, 1903.

1904. Smith, R. G. Die bakterielle Ursprung der Gummiarten der Arabin group. **3**: Die wahrend des Wachstums von *Bact. acaciae* und *Bact. metarabinum* in Saccharosemedien erzeugten Sauren. Centralb. f. Bakt. **11**: 698–703, 1904.

Bacterium preisii Laxa, 1917

Isolated from the juice of sugar beets.

Literature:

1917. Laxa, O. Die Schleimfäule der Zuckerrübe. Zeit. Zuckerind. Böhmen. **41**: 309–318, 1917.

Bacterium punctatum (Zimmerman) Lehmann and Neumann, 1896

Isolated from potatoes showing wet rot.

Literature:

1890. Zimmermann, O. E. R. Die Bakterien unserer Trink—und Nutzwasser. Bericht der Naturwissenschaftlichen Gesellschaft zu Chemnitz. **11**: 86–87, 1890. *Bacillus punctatus.*

1896. Lehmann, K. B. und R. O. Neumann. Atlas und grundriss der Bakteriologie. **2**: 238, 1896. *Bacterium punctatum* (Zimm.) Lehm. et Neum. Syn. *Bacillus punctatus* Zimm.

1908. Swellengrebel, N. H. Sur la nature et les causes de la maladie des taches en couronne chez la pomme de terre. Arch. Neerland. Sci. Exact. et Natur. **13**: 151–195, 1908.

Bacterium putredinis Davaine, 1868

Said to cause a wet rot of *Stapelia, Aloe, Echinopsis, Opuntia.*

Synonymy: *Bacillus putredinis* Trevisan, 1889.

Literature:

1868. Davaine, M. C. Recherches physiologiques et pathologiques sur les bacteries. Compt. Rend. Acad. Sci. (Paris) **66**: 499–503, 1868.

1868. Dechambre, A. Dictionnaire Encyclopedique des Sciences Medicales 1 ser., **8**: 23–24, 1868.

1889. Saccardo, P. A. Sylloge Fungorum **8**: 1025, 1889.

1911. Smith, E. F. Bacteria in Relation to Plant Diseases, **2**: 77, 1911.

Bacterium puttemansi Kufferath, 1921

Isolated from tomatoes pickled in brine. Causes rounded, yellowish, swollen spots on the surface of the fruit under the skin.

Literature:

1921. Kufferath, M. *Bacterium puttemansi* Kufferath nov. spec. microbe produisant des taches sur la tomate (*Lycopersicum esculentum*) conservee. Bul. Soc. Roy. Bot. Belgique **54**: 190–194, 1921.

Bacterium rangiferinum Honing, 1912

Associated with bacteria causing wilt of tobacco.

Literature:

1912. Honing, J. A. Over Rottingsbacterien uit slijmzieke Tabak en djatti en enkele andere van slijmziekte verdachte Planten. Mededeel. van Het Deli Proefstation te Medan. Jaargang **7**: 6e afl. 223–253, 1912.

1913. Honing, J. A. Über Faulnisbakterien aus kranken Examplaren von einigen tropischen Nutzpflanzen (tabak, sesam, erdnuss, djatti, und *Polygala butyracea* Heckel). Centralb. f. Bakt. **37**: 364–384, 1913.

Bacterium rubrum Migula, 1900

Isolated from germinating barley roots.

Literature:

1910. Zikes, H. Über Bakterienzoogloenbildung an den Wurzeln der Gerstenpflanzen. Zeitschr. f. das Gesamte Brauwesen. **33**: 357–360, 1910.

Bacterium sacchari R. G. Smith, 1902

Isolated from gummed and healthy sugar canes.

Literature:

1902. Smith, R. G. An ascobacterium from the sugar cane with notes upon the nature of the slime. (*Bacterium sacchari* n. sp.) Proc. Linn. Soc. N. S. Wales **27**: 137–145, 1902.

1902. Smith, R. G. The gummosis of sugar cane. Centralb. f. Bakt. **9**: 805–807, 1902.

Bacterium shuffneri Honing, 1912

Associated with bacteria causing wilt of tobacco.

Literature:

1912. Honing, J. A. Over Rottingsbacterien uit slijmzieke Tabak en djatti en enkele andere van slijmziekte verdachte Planten. Mededeel. van Het Deli Proefstation te Medan. Jaargang **7**: 6e afl. 223–253, 1912.

1913. Honing, J. A. Über Faulnisbakterien aus kranken Examplaren von einigen tropischen Nutzpflanzen (tabak, sesam, erdnuss, djatti, und *Polygala butyracea* Heckel). Centralb. f. Bakt. **37**: 364–384, 1913.

Bacterium stalactitigenes Honing, 1912

Associated with bacteria causing wilt of tobacco.

Literature:

1912. Honing, J. A. Over Rottingsbacterien uit slijmzieke Tabak en djatti en enkele andere van slijmziekte verdachte Planten. Mededeel. van Het Deli Proefstation te Medan. Jaargang **7**: 6e afl. 223–253, 1912.

1913. Honing, J. A. Über Faulnisbakterien aus kranken Examplaren von einigen tropischen Nutzpflanzen (tabak, sesam, erdnuss, djatti, und *Polygala butyracea* Heckel). Centralb. f. Bakt. **37**: 364–384, 1913.

Bacterium sumatranum Honing, 1912

Associated with bacteria causing wilt of tobacco.

Literature:

1912. Honing, J. A. Over Rottingsbacterien uit slijmzieke Tabak en djatti en enkele andere van slijmziekt verdachte Planten. Mededeel. van Het Deli Proefstation te Medan. Jaargang **7**: 6e afl. 223–253, 1912.

1913. Honing, J. A. Über Faulnisbakterien aus kranken Examplaren von einigen tropischen Nutzpflanzen (tabak, sesam, erdnuss, djatti, und *Polygala butyracea* Heckel). Centralb. f. Bakt. 37: 364–384, 1913.

Bacterium termo Dujardin, 1841

Isolated from reddened canes and juice of sorghum.

Literature:

1841. Dujardin, F. Hist. Nat. des Zoophytes infusoires. Paris Mem. sur une classification des infusoires en rapport avec leur organization. Compt. Rend. Acad. Sci. (Paris) 11: 281–286, 1840. Microsc. Journ. 1: 53–56, 1841. (This reference from Buchanan, R. E. General Systematic Bacteriology 539, 1925).

1883. Palmeri, P. e O. Comes. Notizie preliminari sopra alcuni fenomeni di fermentazione del Sorgo saccarino vivente. Rend. R. Accad. Sci. Fis. e Mat. Napoli 22: 310–312, Dic. 1883.

1905. Smith, E. F. Bacteria in Relation to Plant Diseases, 1: 166, 1905.

1925. Buchanan, R. E. General Systematic Bacteriology 215, 1925.

Bacterium tumescens Zopf, 1883

Isolated from cooked slices of moor beet when held in a damp chamber.

Literature:

1883. Zopf, W. Die Spaltpilze 66–67, 1883.

1888. Koch, A. Ueber Morphologie und Einwickelungsgeschichte einiger endosporer Bakterienformen. Bot. Zeitung 46: 314–318, 1888.

Bacterium vermiforme Ward, 1892

(This with a yeast make up what is known as the ginger beer plant.) See Smith, E. F., 2: 163–166, 1911.

Literature:

1892. Ward H. Marshall. The "ginger-beer plant," and the organisms composing it: a contribution to the study of fermentation-yeasts and bacteria. Proc. Roy. Soc. London 50: 261–265, 1892. A preliminary note.

1892. Ward H. Marshall. The ginger-beer plant, and the organisms composing it: a contribution to the study of fermentation-yeasts and bacteria. Philos. Trans. Roy. Soc. London 183: 125–198, 1892.

Bacterium zinnioides Honing, 1912

Associated with bacteria causing wilt of tobacco.

Literature:

1912. Honing, J. A. Over Rottingsbacterien uit slijmzieke Tabak en djatti en enkele andere van slijmziekte verdachte Planten. Mededeel. van Het Deli Proefstation te Medan. Jaargang 7: 6e afl. 223–253, 1912.

1913. Honing, J. A. Über Faulnisbakterien aus kranken Examplaren von einigen tropischen Nutzpflanzen (tabak, sesam, erdnuss, djatti, und *Polygala butyracea* Heckel). Centralb. f. Bakt. **37**: 364–384, 1913.

Bacterium zinnioides non-liquefaciens Honing, 1912

Associated with bacteria causing wilt of peanut.
Literature:

1912. Honing, J. A. Over Rottingsbacterien uit slijmzieke Tabak en djatti en enkele andere van slijmziekte verdachte Planten. Mededeel. van Het Deli Proefstation te Medan. Jaargang **7**: 6e afl. 237, 1912.

Diplococcus tumefaciens Blumenthal und Hirschfeld, 1917

Separated from impure cultures of *Bacterium tumefaciens* and said to produce tumor growth on slices of beet.
Literature:

1917. Blumenthal, F. und H. Hirschfeld. Untersuchungen über bösartige Geschwülste bei Pflanzen und ihre Erreger. Zeitschr. f. Krebsforsch. **16**: 51–58, 1917.

Fluobacillus (Bacillus) albus Senus, 1890

Isolated from rotting leaves.
Literature:

1890. Senus, A. H. C. van. Bijdrage tot de kennis der cellulosegisting. T. M. H. Leonards, Leiden, pp. 1–186, 1890. (Thesis for doctorate at Rijks-Hoogeschool te Leiden.) (Original not seen.) Abstract in Koch, A. Jahresbericht Gährungs-Organismen u. Enzym. 1 (1890): 136–139, 1891.

Fluobacillus (Bacillus) flavus Senus, 1890

Isolated from rotting leaves.
Literature:

1890. Senus, A. H. C. van. Bijdrage tot de kennis der cellulosegisting. T. M. H. Leonards, Leiden, pp. 1–186, 1890. (Thesis for doctorate at Rijks-Hoogeschool te Leiden.) (Original not seen.) Abstract in Koch, A. Jahresbericht Gährungs-Organismen u. Enzym. 1 (1890): 136–139, 1891.

Micrococcus albidus Roze, 1896

Isolated from sections of potato infected with Mucedinee.

The organism is described as white and $\frac{2}{3}$ μ in diameter.

There is no proof of its pathogenicity.

This name was used earlier.

Micrococcus albidus Loski 1893, (from Migula System der Bakterien **2**: 93, 1900).

Micrococcus albidus Henrici 1894, (from Migula System der Bakterien **2**: 105, 1900).

Literature:

1896. Roze, E. Sur une nouvelle bacteriacee de la pomme de terre. Bul. Soc. Mycol. de France 12: 122–125, 1896.

1896. Roze, E. Sur deux nouvelles bacteriacees de la pomme de terre. Compt. Rend. Acad. Sci. (Paris) 122: 750–751, 1896.

1897. Roze, E. Nouvelles observations sur les bacteriacees de la pomme de terre. Bul. Soc. Mycol. France, 13: 29–32, 1897.

Micrococcus aurantiacus sorghi Bruyning, 1897

Said to cause red spots on leaves and sheaths of sorghum.

A coccus or cocciform bacillus; doubtfully motile; forms yellow spots on potato, is slightly viscous and destroys starch; milk coagulated; gelatin not liquefied. No inoculations were made.

See Elliott and Smith 1929.

Literature:

1897. Bruyning, F. F. La brulure du sorgho (Maladie du sorgho sucré, sorghum blight, hirsebrand, sorghum-roodziekte) et les bacteries que la provoquent. Arch. Neerl. Sci. Exact. et Nat. 1: 297–330, 1897.

1929. Elliott, C., and Erwin F. Smith. A bacterial stripe disease of sorghum. Journ. Agr. Res. 38: 17–18, 1929.

Micrococcus cruciformis Freire, 1899

Isolated from the surfaces of pistils and stamens of *Hibiscus*.

Literature:

1899. Freire, D. Les microbes des fleurs. Compt. Rend. Acad. Sci. (Paris) 128: 1047–1049, 1899.

Micrococcus cytophagus Merker, 1911

Occurs on *Elodea* destroying the tooth like projecting marginal cells.

Literature:

1911. Merker, E. Parasitische Bakterien auf Blattern von *Elodea*. Centralb. f. Bakt. 31: 578–590, 1911.

Micrococcus delacourianus Roze, 1896

He states he discovered this *Micrococcus* n. sp. in dry rotting potatoes which were cut and placed under a bell jar in moist air. In 3 days numerous little whitish mucous sphaerules appeared on the surface of the black gangrene. These he named *Micrococcus delacourianus*.

1.5–2μ spheres, dividing ones 3–4μ.

"I have named it *Micrococcus delacourianus* considering it as the first cause of the formation of this black gangrene of the variety Royale." No proof is offered.

Literature:

1896. Roze, E. Un nouveau microcoque de la pomme de terre et les parasites de ses grains de fécule. Compt. Rend. Acad. Sci. (Paris) 123: 1323–1324, 1896.

1896. Roze, E. Nouvelles observations sur les bacteriacees de la pomme de terre. Compt. Rend. Acad. Sci. (Paris) 123: 613–615, 1896.

Micrococcus dendroporthos Ludwig, 1891

Said to cause small gum producing cankers on the bark of young trees of *Populus* sp.

The organism is not described.

Literature:

1891. Ludwig, F. Der Milch- und Rothfluss der Baume und ihre Urheber. Centralb. f. Bakt. 10: 10–13, 1891.
1892. Ludwig, F. Lehrbuch der Niederen Kryptogamen, pp. 91–92, 1892.
1897. Massee, G. Slime-flux. Bul. Miscell. Information, Royal Gardens Kew. No. 132: 423, 1897.
1901. Ludwig, F. Pilzflüsse der Baume. Centralb. f. Bakt. und Parasit 7: 350–352, 1901.

Micrococcus flavidus Roze, 1896

Isolated from growth on cut sections of potato.

No pure culture inoculations were made and the organism is only described as yellow and 1μ in diameter. Found only once in a rotting potato.

This name was used earlier.

See *Micrococcus flavidus* Henrici 1894.

See Migula 1900.

Literature:

1896. Roze, E. Sur des bacteriacees de la pomme de terre. Bul. Soc. Mycol. de France 12: 55–63, 1896.
1896. Roze, E. Sur une nouvelle bactériacée de la pomme de terre. Bul. Soc. Mycol. France 12: 122–125, 1896.
1896. Roze, E. Sur deux nouvelles bacteriacees de la pomme de terre. Compt. Rend. Acad. Sci. (Paris) 122: 750–751, 1896.
1900. Migula, W. System der Bakterien 2: 153–154, 1900.

Micrococcus imperatoris Roze, 1896

Found in the interior of Richter's Imperator potato. Transverse section showed irregular grayish spots with a darker colored contour and a diameter of 1–2 centimeters. Sections were placed under a bell jar at 10–15°C. At end of 24 hours the grayish spots exude a large number of small spherical milky droplets which fused after 2–3 days, covering the entire surface of the spots with a thin layer of whitish liquid. The inoculation did not succeed on a tuber kept in moist air but was more successful on a tuber in a very wet earth.

Literature:

1896. Roze, E. Sur quelques bactériacées de la pomme de terre. Compt. Rend. Acad. Sci. (Paris) 122: 543–545, 1896.
1896. Roze, E. Sur des bactériacées de la pomme de terre. Bul. Soc. Mycol. France. 12: 55–63, 1896.

Micrococcus luteus (Schröter) Cohn 1872

Associated with bacteria causing wilt of tobacco.

Synonymy:

Bacteridium luteum Schröter, 1872.

Literature:

1872. Cohn, F. Untersuchungen über Bakterien. Beitr. Biol. Pflanz. 1: 153, 1872.

1872. Schröter, J. Ueber einige durch Bakterien gebildete Pigmente. Beitrage Biol. Pflanzen Heft 2, 1: 119, 1872.

1912. Honing, J. A. Over Rottingsbacterien uit slijmzieke Tabak en djatti en enkele andere van slijmziekte verdachte Planten. Mededeel. van Het Deli Proefstation te Medan. Jaargang 7: 6e afl. 223–253, 1912.

Micrococcus malolacticus Seifert, 1926

Said to cause brownish or reddish spots a few millimeters in diameter on leaves toward the ends of the shoots of grape. In time the spots coalesce and become a vivid red or a purple red. The disease is said to be a mixed infection primarily due to this organism and *Micrococcus staphylophagus* f. *vitis*.

Literature:

1926. Serbinov, I. L. (On the etiology of the "variole suisse" of the vine.) La Defense des Plantes. Leningrad 2: 556–561, 1926. (In Russian.) From Rev. Appl. Mycol. 5: 650, 1926.

Micrococcus melanocyclus Merker, 1911

Said to attack the marginal tooth cells of *Elodea* destroying the cellulose walls.

Literature:

1911. Merker, E. Parasitische Bakterien auf Blattern von *Elodea*. Centralb. f. Bakt. 31: 578–590, 1911.

Micrococcus nuclei Roze, 1896

Found in nuclei killed by internal brown rot of potato.

No pure cultures, and no inoculations to prove pathogenic properties, were made.

Literature:

1896. Roze, E. Sur quelques bactériacées de la pomme de terre. Compt. Rend. Acad. Sci. (Paris) 122: 543–545, 1896.

1896. Roze, E. Sur des bactériacées de la pomme de terre. Bul. Soc. Mycol. France 12: 55–63, 1896.

1900. Migula, W. System der Bakterien 2: 196–197, 1900.

Micrococcus pellucidus Roze, 1896

Isolated from young lesions of potato scab.

No pure culture inoculations were made and no description of the organism was given.

Synonymy: *Micrococcus pellicidus* Roze, 1896.

Literature:

1896. Roze, E. Sur la cause premiere de la maladie de la gale de la pomme de terre (potato scab) des Americains. Compt. Rend. Acad. Sci. (Paris) 122: 1012–1014, 1896.

1896. Roze, E. La cause premiere de la maladie de la gale de la pomme de terre (potato scab) des Americains. Bul. Soc. Mykol. de France 12: 126–132, 1896.

1896. Roze, E. Nouvelles observations sur la maladie de la gale de la pomme de terre. Compt. Rend. Acad. Sci. (Paris) 123: 759–761, 1896.

1897. Roze, E. La maladie de la gale de la pomme de terre et ses rapports avec le *Rhizoctonia solani* Kühn. Bul. Soc. Mycol. France 13: 23–28, 1897.

Micrococcus prodigiosus Cohn, 1872

Said to cause the formation of cavities inside the potato thru the complete destruction of the starch and cell walls; the walls of the cavities are coral red.

There is no description of the organism except that it colors red the substance on which it grows. There is no proof of its pathogenicity.

Synonymy: According to Migula a synonym of *Bacillus prodigiosus* (Ehrenberg) Flügge.

Literature:

1872. Cohn, F. Untersuchungen uber Bakterien 1: 1872.

1900. Migula, W. System der Bakterien 2: 845–847, 1900.

1924. Cavadas, D. S. Sur des tubercules de pommes de terre attaques par le *Micrococcus prodigiosus.* Revue Pathol. Véget. et D'Entom. Agric. 11: 19–20, 1924.

Micrococcus pyogenes (Rosenbach) Migula, 1900

Associated with *Bacterium solanacearum* causing wilt of tobacco.

Synonymy:

Micrococcus pyogenes albus Lehmann and Neumann, 1896.
(See Migula 1900.)

Literature:

1900. Migula, W. System der Bakterien 2: 87, 1900.

1912. Honing, J. A. Over Rottingsbacterien uit slijmzieke Tabak en djatti en enkele andere van slijmziekte verdachte Planten. Mededeel. van Het. Deli Proefstation te Medan. Jaargang 7: 6e afl. 223–253, 1912.

Micrococcus staphylophagus f. vitis Serbinov, 1926

Said to cause brownish or reddish spots a few millimeters in diameter on leaves toward the ends of the shoots of grape. In time the spots coalesced and became a vivid red or a purple red. The disease is said to be a mixed infection primarily due to this organism and *Micrococcus malolacticus* Seifert.

Literature:

1926. Serbinov, I. L. (On the etiology of the "variole suisse" of the vine.) La Defense des Plantes. Leningrad, 2: 556–561, 1926. (In Russian.) From Rev. Appl. Mycol. 5: 650, 1926.

Micrococcus tritici Prillieux, 1895

Said to cause a shriveling and reddening of wheat grains. No cultures were made and the reader is left in doubt as to the etiological relation of the organism to the disease.

Literature:

1878. Prillieux, E. Sur la coloration et le mode d'alteration de grains de blé roses. Ann. des Sci. Natur. Bot. 8: 248–258, (1878). Published in 1879. This is Prillieux's principal paper and the only one really necessary to consult. Others from the same author are merely abstracts from it. With the exception of the first paper on pear blight by Burrill (1877) this is the earliest paper on a bacterial disease of plants.

1878. Prillieux, E. Sur le mode d'alteration de grains de blés colorés en rose. Bul. des seances de la Soc. Centrale d'Agric. 38: 584–587, 1878. He says the rose color is due to a Micrococcus probably *Micrococcus prodigiosus* Cohn.

1879. Prillieux, E. Corrosion de grains de blé colorés ene rose par des bacteriés. Bul. de la Soc. Bot. de France 26: 31–33, 1879. A *Micrococcus* destroys the starch grains and fills the resulting pockets. No species name given and no description of an organism.

1891. Woronine, M. Ueber das "Taumelgetreide" in Sud-usserien. Bot. Zeitung No. 6: 84–93, 1891. Woronine mentions that among many other organisms found by him on the diseased and poisonous wheat grains he observed on (in) certain red kernels a great number of Micrococci which recalled Prillieux's description in Annales des Science Naturelle, Botanique.

1892. Griffiths, A. B. Sur la matiere colorante du *Micrococcus prodigiosus*. Compt. Rend. Acad. Sci. (Paris) 115: 321–322, 1892. This is a short note on the coloring matter of *Micrococcus prodigiosus* in which he states that this was probably the organism observed by Prillieux. Griffiths says that he has himself infected kernels of germinating wheat.

1895. Prillieux, E. Maladies des plantes agricoles 1: 7–11, 1895.

1924. Draghetti, A. Un caso di arrossamento delle cariossidi osservato su un frumento nel 1924. (A case of the reddening of the caryopses observed on a wheat variety in 1924.) L'Italia Agricola pp. 165–168, Piacenza 1925. (Abstract in Riv. Patol. Veg. 15: (3–4), 67, 1925.) This reference from Rev. Appl. Mycol. 4: 530, 1925. The author describes a case of heavy infection due to *Micrococcus tritici* Prillieux in 1924 on *Triticum turgidum* at the Stazioni Agraria of Forli and estimates the loss at 82 per cent of the crop.

Micrococcus ulmi Brussoff, 1925

Isolated from diseased elm trees showing wilting and yellowing of foliage, a sudden wilting of tips of branches which curl up and dry, and browning of a ring of wood near the cambium with a mass of brown fluid like excretion or the browning of bundles of wood in points or streaks with sound wood between. The curled up tops are entirely discolored in the interior.

More recent investigations have shown that the disease is caused by a fungus; *Graphium ulmi*. The disease occurs in northern Europe.

Synonymy: (Tubeuf suggests this may be the same as the willow disease due to *Bacterium salicis*.)

Literature:

1920. Tubeuf, C. von. Absterben der Ulmenäste im Sommer 1920. Naturwiss. Zeitschr. f. Forstw. und Landw. **18**: 228–230, 1920.

1921. Spierenburg, D. Eene onbekende ziekte in de iepen. Plantenziekt. Waarnem. I. Versl. en Med. Phytopath. Dienst Wageningen **18**: 3–10, 1921. **24**: 3–31, 1922.

1922. Schwarz, M. B. Das Zweigsterben der Ulmen, Trauerweiden und Pfirsichbäume. Mededeel. uit het Phytopathologisch Laboratorium "Willie Commelin Scholten" Baarn 5: 1–32, 1922. (Translation by L. D. Kelsey published by Bartlett Research Laboratories. Bul. 1, 1928.) She names and describes *Graphium ulmi* nov. spec. as the cause of the disease.

1922. Valckenier-Suringar J. Eine Ulmenkrankheit in Holland. Mit. Deutsch. Dendrolog. Gesellschaft. **32**: 145–147, 1922. He questions the accuracy of the conclusion of Schwarz that *Graphium ulmi* is the cause of the disease.

1924. Pape, H. Ein Massensterben von Ulmen in Deutschland. Nachrichtenbl. f. d. Deutschen. Pflanzenschutz. **4**: 84–85, 1924. He came to the conclusion that the elm disease was due to the unfavorable weather conditions of the previous year.

1924. Pape, H. Das Ulmensterben in Deutschland. Mitteil. Deutschen Dendrolog. Gesellsch. 284–288, 1924.

1925. Brussoff, A. Die hollandische Ulmenkrankheiten-eine Bakteriosis. Centralb. f. Bakt. **63**: 256–267, 1925.

1925. Tubeuf C. von. Die holländische Ulmenkrankheit—eine neue Bakteriose. Centralb. f. Bakt. **63**: 256–266, 1925.

1925. Höstermann, G. und M. Noack. Über das Ulmensterben am unteren Rhein. Mitteil. Deutschen Dendrologischen Gesellschaft. 287–289, 1925.

1925. Höstermann, G. und M. Noack. Zum Ulmensterben. Gartenwelt **29**: 549–550, 1925. He considers that the etiology of the disease is still obscure.

1926. Brussoff, A. Das Ulmensterben. Die Umschau **30**: 950–954, 1926.

1926. Brussoff, A. Das Uebergreifen des *Micrococcus ulmi* auf Ahorne und Linden. Zeitschrift f. Pflanzenkr. **36**: 269–274, 1926.

1926. Brussoff, A. Das Übergreifen von *Micrococcus ulmi* auf Rotbuchen und kanadische Pappeln. Zeitschr. f. Pflanzenkr. **36**: 351–355, 1926. He records as new hosts in Germany. *Fagus sylvatica*, *Populus canadensis*.

1927. Brussoff, A. Die Ulmenkrankheit und ihr Ubergreifen auf Rotbuchen und andere Baumarten. Zeitschr. f. Forst. u. Jagdwesen **59**: 147–152, 1927.

1927. Brussoff, A. Über das durch Bakterien verursachte Sterben der Ulmen und anderer Laubbäume. Mitteil. Deutschen Dendrologischen Gesellschaft. **38**: 244–251, 1927. He still maintains that *Micrococcus ulmi* is the cause of die-back of elms.

1927. Brussoff, A. Kritische Bemerkungen zu dem Artikel uber das Ulmensterben von gräfin von Linden und Lydia Zenneck. Cent-

ralb. f. Bakt. 71: 298–300, 1927. Brussoff confirms his early point of view that *Micrococcus ulmi* is the cause of the elm disease and criticises the infection experiments of Linden and Zenneck.

1927. Day, W. R. The prohibition of the importation of elms and the new disease. Quart. Jour. Forestry 21: 123–129, 1927.

1927. König. Ulmensterben in Hamburg. Möllers Deutsche Gartnerzeit. 42: 133–134, 1927. Abstract in Centralb. f. Bakt. 72: 8–14, 347, 1927.

1927. Linden, G. von und Lydia Zenneck. Untersuchungen über das Ulmensterben in den Beständen der Stadtischen Gartenverwaltung der Stadt Boma und Anderer Orte. Centralb. f. Bakt. 69: 340–351, 1927. The results of their investigations confirm the results of Schwarz work. *Graphium ulmi* Schwarz is the cause of the elm disease.

1927. Linden G. von und L. Zenneck. Erwiderung auf die kritischen Bemerkungen von Brussoff zum Ulmensterben. Centralb. f. Bakt. 71: 300–302, 1927. They emphasize in this reply that the constant presence of *Graphium ulmi* in all disease foci led them to the confirmation of Schwarz view. There is always the possibility they think that different causes, perhaps also mixed infection, can produce the disease.

1927. Wilson, M. The Dutch Elm Disease. Gard. Chron. 81: 133–134, 1927. "Although Brussoff's work does not appear to be altogether satisfactory and requires confirmation, it is up to the present, the best explanation that has been given." He says infection experiments with *Graphium ulmi* have all given negative results.

1927. Wollenweber, H. W. Das Ulmensterben und sein Erreger *Graphium ulmi* Schwarz. Nachrichtenbl. Dtsch. Pflanzenschutzdienst. 7: 97–100, 1927. (Translation by L. D. Kelsey, Bartlett Research Lab. Bull. 1, 1928.) He states that inoculation tests prove that *Graphium ulmi* Schwarz is the cause of the dying of elms and that Brussoff's idea that it is due to *Micrococcus ulmi* is incorrect. Pure culture inoculations with *Graphium ulmi* isolated from *Ulmus* species in different parts of Germany produced typical wilting and internal discoloration in every case in five weeks, showing that this organism is the primary cause of the disturbance. Inoculations on maple, lime, hawthorne and poplar gave negative results.

1928. Brussoff, A. Ueber die Ursache des Ulmensterbens. Eine Erwiderung auf den Artikel von Dr. C. Stapp. Mitt. Deut. Dendrol. Ges. 40: 292–297, 1928.

1928. Buismann, C. J. "De oorzaak van de iepenziekte." Tijdschr. Ned. Heidemaatsch. 40: 338–344, 1928. She considers *Graphium ulmi* the cause of the elm disease.

1928. Stapp, C. Über die Ursache des Ulmensterbens. Mitt. Deutschen. Dendrol. Gesellsch. 40: 139–146, 1928.

1928. Uphof, J. C. T. Zur Frage der Ulmenkrankheit in Europe. Zeitschr. f. Pflanzenkr. u. Pflanzenschutz. 38: 222–224, 1928.

1928. Wollenweber, H. W. und C. Stapp. Untersuchungen über die als Ulmensterben bekannte Baumkrankheit. Arb. Biol. Reichsanst. f. Land. u. Forstw. **16**: 283–324, 1928.

1928. The European Elm Disease. A compilation of the more important available information. Barlett Research Laboratories Bul. **1**: 5–15, 1928. Schwarz, M. B. The Twig Wilt and the vascular disease of the Elm. Translated by L. D. Kelsey. Wollenweber, H. W. Elm blight and its cause, *Graphium ulmi* Schwarz. Translated by L. D. Kelsey. Wilson, M. The Dutch Elm Disease. Wilson, M. and M. J. F. Wilson. The Occurrence of the Dutch Elm Disease in England. The authors state here that Wollenweber's infection experiments have proven conclusively that *Graphium ulmi* is the cause of the disease. They also report the disease from England.

1929. Wilson, Mary J. F. Über das Ulmensterben und seinen Erreger. Zeitschr. f. Pflanzenkr. **39**: 36–39, 1929. The results of her inoculations with *Micrococcus ulmi* were negative. She concluded that *Graphium ulmi* was the cause of the disease.

Micrococcus zeae Serbinov, 1926

Isolated from flour, grain and seedlings of corn and regarded as one of the causes of pellagra in South Russia.

No inoculations were made on corn.

Literature:

1926. Serbinov, I. L. Sur la question du pellagra en connection avec la theorie du "blanc de mays." La Defense des Plantes **2**: 546–556, 1926.

Phytobacter lycopersicum Groenewege, 1912

Isolated from rotting tomato fruits.

The author creates this new genus without stating whether the flagella are polar or peritrichiate.

See *Bacterium briosii* Pavarino.

Literature:

1912. Groenewege, J. De Rotting der Tomaten-vruchten, veroorzaakt door *Phytobacter lycopersicum* n. sp. Meded. Rijks. Hoogere Land., Tuin-en Boschbouwschool (Wageningen). dell 5, aft. **5**: 217–239, 1912.

1913. Groenewege, J. Die Fäule der Tomatenfrüchte, verursacht durch *Phytobacter lycopersicum* n. sp. Centralb. für Bacteriologie. II **37**: 16–31, 1913.

1922. Schowers, T. A. C. Ziekten en Beschadigingen van Tomaten. Tijdschr. over Plantenziekten **28**: 67–93, 1922. In Holland nose rot due to *Phytobacter lycopersicum* attacks the tomatoes lowest on the vine. Bacteria from the soil are spattered on to the tomatoes, enter thru wounds and cause brown spots.

Pseudocommis vitis Roze, 1897

Isolated from dry gangrene of potato.

Literature:

1897. Roze, E. Sur la pourriture des pommes de terre. Compt. Rend. Acad. Sci. (Paris) **125:** 1118–1120, 1897.

Pseudomonas amaranti E. F. Smith, 1901

Isolated from plants of *Amaranthus* which were stunted and drooped and dried up without any visible cause. No plate cultures and no inoculations were made.

Synonymy:

Bacterium amaranthi (E. F. Smith) E. F. Smith, 1914;
Phytomonas amaranthi (E. F. Smith) Bergey et al., 1923.

Literature:

1901. Smith, E. F. The cultural characters of *Pseudomonas hyacinthi*, *Ps. campestris*, *Ps. phaseoli* and *Ps. stewarti*,—four one flagellate yellow bacteria parasitic on plants. U. S. Dept. Agric., Div. Veg. Phys. and Path. Bul. **28:** 153, 1901.
1914. Smith, E. F. Bacteria in relation to plant diseases. **3:** 148–150, 1914.
1923. Bergey's Manual of Determinative Bacteriology. 186, 1923.

Pseudomonas araliae Uyeda, 1911

0.6–0.7 x 1.5–2.0μ; motile by one to three polar flagella; Gram negative; gelatin liquefied; bluish to grayish white on agar becoming brown; no diastatic action; no gas; yellowish white on potato; nitrates reduced; indol and hydrogen sulphide produced.

Associated with *Bacillus araliavorus* in the red rot of ginseng.

Literature:

1911. Uyeda, Y. Die Roth-faule von Ginseng verursachtet durch *Bacillus araliavorus* und einige anderen bakterien Arten. Miyabe-festschr. 75–113, 1911.

Pseudomonas fluorescens exitiosus van Hall, 1903

Said to cause soft rot of shoots and bulbs of iris.

No description of the organism is given.

Literature:

1903. van Hall, C. J. J. Das Faulen der jungen Schasslinge und Rhizome von *Iris florentina* und *Iris germanica*, verursacht durch *Bacillus omnivorus* v. Hall und durch einige andere bakterien Arten. Zeitschr. f. Pflanzenkr. **13:** 129–144, 1903.

Pseudomonas koraiensis Uyeda, 1911

Associated with *Bacillus araliavorus* in the red spot of ginseng.

Literature:

1911. Uyeda, Y. Die Roth-fäule von Ginseng verursachtet durch *Bacillus araliavorus* und einige anderen bakterien Arten. Miyabe—festschrift. 75–113, 1911.

Pseudomonas polycromigena Perotti, 1914

Constantly associated with a fungus fruit spot of tomato.

Literature:

1914. Perotti Re U. Cristofoletti. Sopra una tacca nero-olivacea dei frutti di pomodoro causata dal *Cladosporium herbarum.* Staz. Sperim. Agrar. Ital. 47: 169–216, 1914.

CHRONOLOGICAL CHARTS OF PLANT PATHOGENS

MORPHOLOGICAL, CULTURAL, AND PHYSIOLOG

	DATE NAMED	HOST	GRAM	ACID FAST	OXY-GEN Aerobe	OXY-GEN Facultative anaerobe	GELATIN LIQUEFACTION	NI-TRATES Reduction	NI-TRATES Gas	CHROMOGENE
Bacterium										
hyacinthi	1883	hyacinth	−		+		+	−		yellow
mori	1893	mulberry	−		+		−	−		white
vasculorum		sugar cane	+		+		−	−		yellow
campestre	1895	cabbage	−	−	+		+	−		yellow
solanacearum	1896	solanaceae	−		+		−	+		white to brow
phaseoli	1898	bean	−	−	+		+	−		yellow
destructans	1899	turnip	−		+		+	+		white
oncidii		orchid								white
juglandis	1901	walnut	+		+		+	−		yellow
malvacearum		cotton	−	−			+	−		yellow
iridis	1902	iris	−			+	−	−		gray-green
syringae		lilac	−				+	+		white fluoresc
mali	1903	apple	−		+		+			white
pyri		pear	−		+		+			yellow
pruni		plum	−	−	+		+	+		yellow
delphini	1904	larkspur	−	−	+		+	−		white fluoresc
fici	1905	fig					+	−		yellow
spongiosus		cherry					+	−		white
leguminiperdum	1906	lupine	−		+	+	+			white
tumefaciens	1907	daisy	−	−	+		−	−		white
savastanoi	1908	olive	−	−	+		−	−		white
levistici	1909	lovage	−				+			white
zingiberi		ginger	−		+		−	+		white
briosii	1910	tomato	+			+	+			yellow
conjac		conjac	+					+		yellow
medicaginis		alfalfa	−		+		−	−		white fluoresc
andropogoni	1911	sorghum	−	−	+		−	−		white
beticola		beet	±	−	+		+	+		yellow
cattleyae		orchid			+		−			white
cerasi		cherry	−	−			+	−		fluorescent
kramerani		orchid	−				+			fluorescent
maculicola		cabbage	−	−	+		+	−		white
montemartinii		wisteria	−		+		−			white
woodsii		carnation					−	−		white
dendrobii		dendrobium	+			+	−			yellow
matthiolae	1912	stock	+		+		+			white
xanthochlorum		potato	−			+	+	+		yellowish whit

ARACTERS OF SPECIES OF BACTERIUM

CARBOHYDRATE REACTIONS: Dextrose Acid	Dextrose Alkaline	Dextrose Gas	Lactose Acid	Lactose Alkaline	Lactose Gas	Sucrose Acid	Sucrose Alkaline	Sucrose Gas	Glycerin Acid	Glycerin Alkaline	Glycerin Gas	VEGETATIVE CELLS: Length	VEGETATIVE CELLS: Diameter	CHAINS	SPORES	CAPSULES	MILK: Curd	MILK: Peptonization	INDOL	HYDROGEN SULPHIDE	AMMONIA	THERMAL DEATH POINT
												microns	*microns*									
+						+						0.8–2.0	0.4–0.6	+	−		+	±	+	+		47.5°C.
		−			−			−			−	1.8–4.5	0.9–1.3	+	−	−	−	+	±			51.5°C.
−		−	−		−	−		−	−		−	0.6–1.5	0.3–0.5	−	−		−					49–50°C.
+		−	+		−	+		−	+		−	0.7–3.0	0.4–0.5	+	−	+	+	±	+	+	+	51°C.
−		−	−		−	−		−				1.5	0.5		−	−	−	+	−		+	52°C.
+		−	+		−	+		−	+		−	0.5–3.0	0.3–0.8		−	+	+	+	−	+	+	50°C.
												3.0	0.8				+	+	+			
						+		+				1.3–1.5	0.8–1.0									
												1.5–3.0	0.3–0.5	+	−	−	+	+	+			
															−		+	+	−			50–51°C.
+		+				+		+				0.9–1.5	0.8	−	−				+	+		53–54°C.
+		−				+		−	+		−	1.2–1.8	0.6	+	−	+	+	+	−	−	+	51°C.
												1.0–3.0	0.6–0.7	+		+						
												2.0	0.6–0.7	+								
+		−	+		−	+		−	+		−	1.6–1.8	0.4–0.6	+			+	+	+			51°C.
+		[illegible]				+		−				1.5–2.0	0.6–0.8	+	−	+	−	+	−	−	+	50°C.
												1.5–2.6	0.5–0.6	+	−	+	−		+			
												1.6–4.0	0.6–0.8	+	−		−	+			+	
												2.0–2.3	0.8		+				−	−		
+		−				+		−				1.0–3.0	0.4–0.8	+	−		+	−	+	+	+	51°C.
+		−				+		−				1.2–3.0	0.4–0.8	+	−		−	+	+			43–46°C.
												1.1–1.5	0.5–1.1		−				+	−		
												0.75–1.8	0.5–1.1		−		+	+	−			
												2.0–4.0	0.4–0.6			+						
		+										1.5	0.75–1.0		−	−	+		+	+		
−		−	−		−	−		−	−		−	1.2–2.4	0.5–0.8	+	−	−	+	−	−	−	+	49–50°C.
+		−	−		−	−		−	−		−	1.3–2.5	0.4–0.8		−	+	−	+	−	−		48°C.
+		−				+		−				0.6–2.0	0.4–0.8	+	−	+	+		−	+	+	51–52°C.
												2.4	0.4–0.6		+							
+		−	+		−	+		−	+		−	1.5–2.5	0.5–0.84		−		+	+			−	48°C.
												2.0–3.0	0.6–0.8		+							
												1.5–3.0	0.8–0.9	+	−		−		+	+	+	46°C.
												6.0–8.0										
															−		−					
												2.0–4.0	0.4–0.6									
												2.0–4.0	0.4–0.6							−		
+		−										1.5–3.0	0.75		−		+	+	+	+		51°C.

	DATE NAMED	HOST	GRAM	ACID FAST	OXYGEN: Aerobe	OXYGEN: Facultative anaerobe	GELATIN LIQUEFACTION	NITRATES: Reduction	NITRATES: Gas	CHROMOGENE
Bacterium—Continued										
aptatum	1913	beet	−	−	+		+	−		white fluores
gladioli		gladiolus	−		+		+	−		yellow-red
erodii	1914	heronbill	−	−	+		+	−		yellow fluore
pseudozoogloea		tobacco	−			+	+	−		yellow
solanacearum var. *asiaticum*		See *Bact. solanacearum*								
citri	1915	citrus	−		+		+	−		yellow
lachrymans		cucumber	−	−	+		+	−		white
viciae		broad bean	+			+	−	−		white to brow
viridilividum		lettuce	−	−			+	−		white
pisi	1916	pea	−	−	+		+	−		white
nectarophilum	1917	pear	−	−		+	−	−		yellow
papulans		apple	−	−	+		+	−		white
seminum		pea	+	−		+	+	+		white
tabacum		tobacco	−	−	+		+	−		white
translucens		barley	−	−	+		+	−		yellow
tritici		wheat					−	+		yellow
marginale	1918	lettuce	−	−	+		+	+		yellow fluores
vitians		lettuce	−	−	+		+	−		yellow
angulatum	1919	tobacco	−	−	+		+	−		white
glycines		soy bean	−				−			yellow
glycineum		soy bean	−	−	+		−	−		white
proteamaculans		protea	+					+		yellow
tolaasi		mushroom	−	−	+	+	+	−		white
transclucens var. *undulosum*		wheat—See *Bact. translucens*								
antirrhini	1920	snapdragon	−		+		+	+	−	yellow
atrofaciens		wheat	−	−	+		+	−		white fluoresc
cerealinum		barley			+		−	−		yellow
coronafaciens		oats	−	−	+		+	+		white
stizolobii		velvet bean	−	−	+		−	−		white
vesicatorium		tomato	+	−	+		+	−		yellow
cannae	1921	canna	−	−	+		+			white
jaggeri		celery					+	−		white
marginatum		gladiolus	−	−			+	−		white
musae		banana	+				−	−		yellow
alboprecipitans	1922	foxtail	−	−	+			+		white
flaccumfaciens		bean	+	−	+		+	−		yellow

CARBOHYDRATE REACTIONS												VEGETATIVE CELLS		CHAINS	SPORES	CAPSULES	MILK		INDOL	HYDROGEN SULPHIDE	AMMONIA	THERMAL DEATH POINT
Dextrose			Lactose			Sucrose			Glycerin													
Acid	Alkaline	Gas	Acid	Alkaline	Gas	Acid	Alkaline	Gas	Acid	Alkaline	Gas	Length	Diameter				Curd	Peptonization				
												microns	*microns*									
												1.2–3.2	0.6–1.3		−	−	+		+		+	47.5–48°C.
												2.3–2.8	0.6		−	−	+	+	−			47°C.
												1.2–1.8	0.6–0.8	+	−	−	+	+	+	−	+	48.5°C.
+		−	+		−	+		−				0.9–2.5	0.7–1.0	+	−		+	−	−	+	+	
−		−	−		−	−		−	−		−	1.5–2.0	0.5–0.75	+	−	+	+		−		+	
+		−				+		−				1.0–2.0	0.8	+	−	+	−	+	+	−		49–50°C.
												1.2–2.0	0.5–0.8		−		+	+		−		49°C.
												1.25–3.0	1.0–1.25	+	−		−	+	+			48–49°C.
+		−				+		−				1.11–3.28	0.58–0.82		−	−	+	+	−	−	+	50°C.
+			−		−	−		−	−		−	0.5–3.0	0.45–0.7	+		+		+	−	+	+	40°C.
+		−			−	+		−			−	0.9–2.3	0.6		−	−	+	+	−		+	
+		−				+		−				4.0–10.0	1.0	+	+	+	−	+				
+		−				+		−				1.4–2.8	0.5–0.75	+	−	−	+		−	−	−	46–51°C.
+		−	+		−	+		−	+		−	1.0–2.5	0.5–0.8	+	−	+	+	+	+		+	50°C.
+		−	+		−							2.4–3.2	0.8							−	+	50°C.
+		−				+		−				0.83–2.08	0.42–1.25	+	−	+	+		−	−	+	52–53°C.
												0.62–1.24	0.42–0.83	+	−	+	+	+	+	+	+	51–52°C.
+		−	−		−	+		−	−		−	2.0–2.5	0.5		−	−	−	+	+			45–51°C.
		−			−			−			−	1.1–2.15	0.27–0.39				−	+	−			
+		−	+		−	+		−				2.3–3.0	1.2–1.5		−	+	+	±	±		+	48–49°C. (C)
																						43–48°C. (W)
+		+	−		−	+		+				0.8–1.6	0.6–0.8			−	+					51–53°C.
+		−	−		−	−		−				0.9–1.7	0.4–0.5			−	+	+	+		+	49–50°C.
												0.8–1.2	0.3–0.4	−	−	+	+	+				51°C.
+		−				+		−				1.0–2.7	0.6	+	−	+	−	+	+	+	+	48–49°C.
												1.5–3.0	0.6–0.8	+	+							
+		−				+		−				2.40	0.68	+	−	+	+	+	−	+	+	48°C.
−		−	−		−	−		−	−		−	1.0–1.6	0.6–0.7	+	−	+	+		−			50°C.
+		−	+		−	+		−	+		−	1.0–1.5	0.6–0.7	+	−	+	+	+	−			56°C.
												1.0–2.0	0.5–0.7	+		+	−	+	−	+	+	52°C.
+		−				+		−				0.87–1.74	0.44–0.87				−	+				
+		−	+		−	+		−	+		−	0.8–1.8	0.5–0.6		−	+	+	+	+	+	+	53°C.
												0.8–1.2			−		+	+	−	−		
−		−	−		−	−		−	−		−	1.8	0.6		−	+			−	−	+	41–43°C.
+		−	+		−	+		−	+		−	0.6–3.0	0.3–0.5	−	−	−	+	+	−	−	+	60°C.

	DATE NAMED	HOST	GRAM	ACID FAST	OXYGEN: Aerobe	OXYGEN: Facultative anaerobe	GELATIN LIQUEFACTION	NITRATES: Reduction	NITRATES: Gas	CHROMOGENES
Bacterium—Concluded										
oryzae		rice	−		+		−			yellow
panaxi		ginseng	−			+	+			white
celebense	1923	banana	−					−		yellow
coronafaciens atropurpureum		brome grass			+		See *Bact. coronafaciens*			
hibisci		hibiscus	−		+		+	+		white
melleum		tobacco	−	−	+		+	−		yellow
panici		proso millet	−	−	+		+	+		white
pelargoni		geranium	−	−	+		+	−		white
trifoliorum		clover	−		+		−	−		white
vignae		cowpea	−				+	−		white
barkeri	1924	pear	+			+	+	−		white
gummisudans		gladiolus	−	−	+		+	−		yellow
lycopersici		tomato	−		+		+			white fluoresc
martyniae		devils claw	−	−	+		+	+		white fluoresc
phaseoli sojense		soy bean	−		+		+	−		yellow
salicis		willow	+	−	+	+	−	−		white
translucens secalis		rye					See *Bact. translucens*			
cerasi wraggi	1925	wragg cherry								yellow—See
cichori		chicory	−				−	−		
intybi		chicory	−				+	+		
rubrilineans		sugar cane	−			+	+	+		buff opalescen
cucurbitae	1926	squash	−				+	−		yellow
holci		sorghum	−		+		+	+		white
medicaginis phaseolicola		bean	−	−		+	−	−		white
tonellianum		oleander			+		−			white
bowlesii	1927	Bowlesia	−	−	+		+	+		yellow
glycineum japonicum		soy bean	−		+		−	−		white
nigromaculans		burdock	−		+		+	−		yellow
petasites		butterbur	−			+	−	+		white
puerariae		kudzu	−	−	+		+	−		white
sesamicola		sesame	−		+		+	−		white
striafaciens		oats	−	−	+		+	+		white
wieringae		beet	−					−		white
rubefaciens	1928	potato	−				+			yellow
suberfaciens		potato	−				−			cream buff
albilineans	1929	sugar cane	−				−			buff yellow
campestre armoraceae		horseradish	−	−	+		+	−		yellow
ricinicola		castor bean	−	−	+		+	−		lemon yellow

ARACTERS OF SPECIES OF BACTERIUM—*Concluded*

CARBOHYDRATE REACTIONS												VEGETATIVE CELLS		CHAINS	SPORES	CAPSULES	MILK		INDOL	HYDROGEN SULPHIDE	AMMONIA	THERMAL DEATH POINT
Dextrose			Lactose			Sucrose			Glycerin													
Acid	Alkaline	Gas	Acid	Alkaline	Gas	Acid	Alkaline	Gas	Acid	Alkaline	Gas	Length	Diameter				Curd	Peptonization				
												microns	*microns*									
												1.0–2.0	0.5–0.8		–		–	+	–	+	–	53°C.
												1.3–1.5	0.5	+			+					50–52°C.
												1.4	0.9		–		+	+				
												1.92–2.25	0.72–0.81									50–51°C.
												1.2–2.0	0.6–0.7	+	–	–		+	–			49°C.
–		–	–		–	–		–	–		–	1.0–2.4	0.5–0.8	+	–	+	+	+	–	–	–	57°C.
												1.66	0.69	+	–	+	–	+	–	+	+	51°C.
												1.02	0.67	+	–	+	+	+	+	+	+	51–51.5°C.
+		–				+		–				1.2–3.0	0.4–1.0	+	–	+	+	–			+	48–49°C.
+		–				+		–				1.1–2.34	0.44–0.66		–	–	–	+	–		+	49–50°C.
–		–	–		–	–		–	–		–	2.0–4.0	0.5–0.8	+	–	–	–	+	+	+	+	
+		–				+		–				1.0–2.8	0.6–0.8		–	+	+	+	–	+	+	50°C.
		+			–			+			–	0.75–1.5	0.5–0.75		–	–	+	±	+	–	+	68°C.
+		–				+		–				1.3–2.2	0.5–0.7	+	–	+	+	+	–	+		49°C.
+		–	+		–							1.4–2.3	0.5–0.9	+	–	–	+	+	–		+	50°C.
+		–	–		–	+		–	+		–	0.8–1.0	0.3–0.4		–	+	–					
asi																						
															–				–			51°C.
															–				–			51°C.
+		–		+			+			+		1.67	0.7		–	–	–	+	–	–	+	51–52°C.
												0.5–1.3	0.45–0.6				+	+				
+		–				+		–				1.5–2.9	0.6–1.0		–	–	–	+	–			49°C.
+		–				+		–				1.5–3.0	0.5–1.25	+	–	–	–	–	–	–		49°C.
+		–										1.9–3.5 1.5–2.5	0.75–1.0 0.5–0.6		–	–	–	+	+			51°C.
+		–										1.2–1.6	0.5–0.7	+		–	+	+	+	+	+	39°C.
+		–				+		–				1.6–3.0	0.6–0.8		–	+			–			47°C.
–		–	–		–	–		–	–		–	1.5–2.8	0.6–0.9		–		+	+	–		+	50°C.
												1.1–1.7	0.8–1.0		–	–	+		–			55–56°C.
+		–				+		–	+		–	0.86–1.67	0.3–0.48	+	–	–	–	+	–	–	+	55°C.
+		–	–		–	–		–	–		–	1.2–3.8	0.6–0.8	+	–		–	+	–		–	49°C.
+						+						1.76	0.66	+	–	+	+	+	–	+	+	48°C.
		–			–			–				2.0	0.5		–		–	+				45°C.
			+		–	+		–				1.6	0.5	–	–							
												2.6	0.6	–	–							
												0.35–2.1	0.12–0.32	+	–		–	+				
+		–	+		–	+		–	+		–	0.7–2.0	0.3–0.5	+		+	–	+	+	+	+	51°C.
			+		–							1.3–2.6	0.4–0.9	+	–	+	–	+				50–51°C.

MORPHOLOGICAL, CULTURAL, AND PHYSIOLOG

	DATE NAMED	HOST	GRAMS	ACID FAST	OXYGEN: Aerobe	OXYGEN: Facultative anaerobe	GELATIN LIQUEFACTION	NITRATES: Reduction	NITRATES: Gas	CHROMOGEN
Bacillus										
amylovorus	1882	pear	−	−	+	+	+	−		white
coli	1886	coconut	−		+		−	+		yellowish
mesentericus		potato	+		+		+	−		white
sorghi	1887	sorghum					−			white
hyacinthi septicus	1889	hyacinth			+	+	−			white
sacchari	1891	sugar cane			+					
gossypina	1894	cotton			+		+			fluorescen
tracheiphilus	1895	cucurbits	−		+	+	−	−		white
alliariae	1896	wasabi			+		+			white
trifolii		clover								white
uvae		grape					+			yellow
bussei	1900	beet					−			white
solaniperda		potato					+			white
carotovorus	1901	carrot	±		+	+	+	+		white
solanincola		potato	−		+		−			yellowish
phytophthorus	1902	potato	−		+	+	+	+		white
lactucae	1903	lettuce								rose
tabificans		beet	−		+					white
aroideae	1904	calla	−			+	+	+		white
brassicaevorus	1905	cabbage	−				−			white to b
putredinis putridus	1906	tobacco					−			white to r
solanisaprus		potato	−			+	+	+		white
tabacivorus		tobacco	−		+		−			white
populi	1907	poplar			+					yellow
scabigenus		beet				+	−			yellow
araliavorus	1909	ginseng	−		+		−	+		white
melonis	1910	muskmelon	−			+	+	+		opalescent
dahliae	1911	dahlia	+			+	−	+		white
farnetianus		orchid	+					+		grayish i cent
harai		willow	+			+	+			white
pollacii		orchid	−		+		+			greenish
asteracearum	1912	aster	+		+	+	+			yellow
cypripedii		orchid	+			+	+			white

ARACTERS OF SPECIES OF BACILLUS

CARBOHYDRATE REACTIONS												VEGETATIVE CELLS					MILK						
Dextrose			Lactose			Sucrose			Glycerin					CHAINS	SPORES	CAPSULES				INDOL	HYDROGEN SULPHIDE	AMMONIA	THERMAL DEATH POINT
Acid	Alkaline	Gas	Acid	Alkaline	Gas	Acid	Alkaline	Gas	Acid	Alkaline	Gas	Length	Diameter				Curd	Peptonization	Gas				
												microns	*microns*										
+		−	+		−	+		−	+		−	0.9–1.5 1.0–1.8	0.7–1.0 0.5–0.9	+	−	−	+	+		−	−	−	45–46°C.
+		+	+		+							1.0–2.0	0.5	+	−		+	−		+			56–57°C.
+						+						1.5–3.0	0.5		+		−	+		−			
												1.0–3.0	0.5–1.0	+	+								
												4.0–6.0	1.0	−									
															+								
												1.5	0.75	+	+								
+		−				+		−	+		−	1.2–2.5	0.5–0.7	−	−	+	−	−		−	+	+	43°C.
												2.5–3.0	1.5										
												1.0–2.5	0.2–0.5		+								
												3.0–4.0	0.25	+									
+		+										1.5–1.75	0.7–0.8	+	−								
												2.5–4.0	0.7–0.8	+	−								
		+			+			+			−	1.5–5.0	0.6–0.9	+	−	−	+	−		+			51°C.
												1.5–1.75	0.25		−								
+			+		+	+						1.5–2.5	0.6–0.8	+	−		+	−		−	+		47°C.
												2.25	0.5		+								
												1.5	1.0		−								
+		−	+		−	+		−	+		−	2.0–3.0 1.5–5.0	0.5 0.7–1.0	+	−	−	+	+	+	±	+		50°C.
												1.25–1.75	0.5–0.75	+	−								
												1.2–1.8	0.5–0.7										
+		−	+		+	+		−	+		−	1.5–4.0	0.6–0.9		−	−	+	−	+	+	+		54°C.
												0.75–1.5	0.4–0.6		−	−							
															+		+	+		+			
								+				1.7–2.12	0.85		−		−						
												1.8–2.0	0.7–0.9	−	−		−			+	−		55°C.
+		−	+		−	+		−	+		−	1.2–1.6	0.7–0.9		−	−	+	−	+	+	+	+	49–50°C.
		+			+			+				1.4–1.6	1.0–1.2		−		+			−	+	+	50°C.
												15.0	0.8–1.0										
												1.8–2.0	1.0–1.2		+		+			+	−	+	55°C.
												8.0–10.0	1.0		+								
												5.0–6.0	0.5–0.6	+									
		+										1.5–2.0	0.5–0.7		−		+			+	+	+	

MORPHOLOGICAL, CULTURAL, AND PHYSIOLOG

	DATE NAMED	HOST	GRAM	ACID FAST	OXYGEN: Aerobe	OXYGEN: Facultative anaerobe	GELATIN LIQUEFACTION	NITRATES: Reduction	NITRATES: Gas	CHROMOGENE
Bacillus—Concluded										
manihotus		cassava	+		+					white
tubifex		potato			+	+	+			white
ixiae	1913	ixia	–			+	+	–		white
lathyri		sweet pea	–		+		+	–		yellow
mangiferae	1915	mango	+	–	+	+	+	+		yellow
serbinowi		beet	–		+		+			white-fluore cent
theae		tea	–			+	+			white to br
citrimaculans	1917	citrus	+	–	+	+	+	+	+	yellow
capsici	1918	red pepper	+			+	+			white
lilii	1919	lily	+			+	+	+		gray
milletiae	1920	Milletia	–			+	+	+		yellow
tracheiphilus f. cucumis		See *B. tracheiphilus*								
flavidus	1922	sugar cane	–				+	–		yellow
nelliae		parsnip						–		white
cacticidus	1923	prickly pear	–		+	+				white to yel
croci		crocus	–	–		+	+	+		white
edgeworthiae	1925	papertree	–			+		+		gray to s fluorescen
erivanensis		cotton	–				+	–		yellow
papaveris	1927	poppy	–			+	+	+		white
ananas	1928	pineapple	–	–		+	+	+		yellow

ARACTERS OF SPECIES OF BACILLUS—*Concluded*

	Carbohydrate reactions: Dextrose, Acid	Dextrose, Alkaline	Dextrose, Gas	Lactose, Acid	Lactose, Alkaline	Lactose, Gas	Sucrose, Acid	Sucrose, Alkaline	Sucrose, Gas	Glycerin, Acid	Glycerin, Alkaline	Glycerin, Gas	Vegetative cells: Length	Vegetative cells: Diameter	Chains	Spores	Capsules	Milk: Curd	Milk: Peptonization	Milk: Gas	Indol	Hydrogen sulphide	Ammonia	Thermal death point
													microns	*microns*										
−							+		+				2.4–5.0	0.8–1.7	+	+		+	+	+				45–50°C.
													1.8–2.3	0.7	+	−	−	+	−		−			47°C.
+	+		−	+		−	+		−	+		−	0.75–1.5	0.6–0.85	−	−	−	+	+		+		+	48–50°C.
−	+		−	+		−	+		−	+		−	0.8–2.6	0.5–0.7	+	−	+	+	+		+	−	+	60°C.
													1.0	0.4–0.75	−	−	−					−	−	
													1.4–1.8	0.8–1.0	+	+		−			+			
	+		−	−		−	+		−	−		−	1.0–4.0	0.45–0.7		−	+	+	−					62°C.
													1.5–3.0	0.8–1.0	+	+		+						
													0.8–1.0	0.6–0.7				+			+	+	+	
−							+		−	+		−	0.9–2.5	0.4–0.6		−	+	−	+					50–53°C.
−	+		−	+		−	+		−	+		−				−		+			+			
	+		+	+		+	+		+	−		−	0.83–2.27	0.37–0.5										53–54°C.
	+			−			+						1.3	0.8		−	−	+						
	+		−	+		−				+		−	1.2–3.2	0.6–1.1	+	−	−	+	+		−	−	+	55°C.
													1.4–2.0	1.2–1.4		−		+			+		+	
			+			−			+			−	1.25–2.5	0.5–0.7		−		+	+		+			
+	+		−	+		−	+		−	+		−	0.5–2.5	0.35		−	−	+	−		+		+	56–60°C.
+	+		−	+		−	+		−	+		−	0.9	0.6	+	−	+	+			−	+	+	56–57°C.

MORPHOLOGICAL, CULTURAL, AND PHYSIOLOGICAL CHARACTERS OF SP
AND

	DATE NAMED	HOST	GRAM	ACID FAST	OXYGEN		GELATIN LIQUEFACTION	NITRATES		CHROMOC
					Aerobe	Facultative anaerobe		Reduction	Gas	
Aplanobacter										
stewarti	1898	corn	−		+		−	−		yellow
teutlium	1904	beet	+			+	−			white
maculicola	1905	tobacco	−				+			cream
cepivorus	1906	onion	−				−			white lic
michiganense	1910	tomato	+	−	+		+	−		yellow
rathayi	1913	orchard grass	+	−			+	−		yellow
sepedonicum	1913	potato	+		+		−			yellow
agropyri	1916	western wheat grass	−	−	+		−	+		yellow
dissolvens	1922	corn	−	−		+	−	+		white
rhizoctonia		lettuce	−	−	+		+	+		yellow
rhaponticum	1924	rhubarb	−				−			yellow
insidiosum	1925	alfalfa	−	−	+		+	−		yellow
betle	1928	betle vine	−		+		+			yellow
Clostridium										
persicae tuberculosis	1897	peach					+			white
Micrococcus										
populi	1906	poplar	−				−			opalesc
Phytomonas										
ricini	1927	castor bean	−	−	+		−	−		gray-w
Proteus										
nadsonii	1915	potato	±				+			yellowi brow
Pseudomonas										
solaniolens	1923	potato					−	−		buff

APLANOBACTER, CLOSTRIDIUM, MICROCOCCUS, PHYTOMONAS, PROTEUS
MONAS

CARBOHYDRATE REACTIONS												VEGETATIVE CELLS		CHAINS	SPORES	CAPSULES	MILK		INDOL	HYDROGEN SULPHIDE	AMMONIA	THERMAL DEATH POINT
Dextrose			Lactose			Sucrose			Glycerin			Length	Diameter				Curd	Peptonization				
Acid	Alkaline	Gas	Acid	Alkaline	Gas	Acid	Alkaline	Gas	Acid	Alkaline	Gas	*microns*	*microns*									
+		−				+		−	−		−	1.0–2.0	0.5–0.7	+	−		−		−	−		53°C.
												1.5	0.8	+	−	−	−		−	−	−	44–46°C.
												1.5	0.75		−							
												1.25	0.9		−							
			−		−				−		−	0.8–1.0	0.35–0.4		−		+					
+		−										0.75–1.5	0.6–0.75		−	+	+					
		−										1.1–1.2	0.5–0.6	+	−	−	+	−	−		−	45–50°C.
−		−	−		−	−		−	−		−	0.6–1.1	0.4–0.6	+		+	−	−				50°C.
+		+	+		+	+		+				0.7–1.2	0.5–0.9	+	−	+	+		+	−	+	
												0.9–1.9	0.4–0.85	+		−	+	+	+	−	+	51–52°C.
+		−	+		−	+		−	+		−	1.75–2.28	0.4		−		+		−			
+		−	+		−	+		−	+		−	0.7–1.0	0.4–0.5	−	−	+	+	−	−	−	−	51–52°C.
												1.5–2.5	0.5	+	−	−						
														+	+							
												1.0–1.5	1.0		−	−						
−		−	−		−	−		−				0.002 mm.	0.0002 mm.		−				−			
												1.0–2.8	0.7	+	−		+	−	−	+	+	
+		−	−		−	−		−	−		−				−		+	−				

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